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Sand Into Glass[1]

New Machines Replace Ancient Skill, But at Corning, N. Y., Industry Still Finds Use for the Power of Human Lungs and René Lalique Keeps 600 Men to Crystallize His Designs.

ASK a chemist about the ingredients of glass and he will talk about silicon. Perhaps the simplest definition of silicon is that it is one of the things that the earth is largely made of. Silica, an oxide of silicon, comprises about three-fifths of the earth's crust. Next to oxygen, silicon is commonest of elements. No politician would refer to the silicon-bound shores of Maine, yet the rocks of Maine (or of almost any other locality) have in their makeup a large silicon content. So common a substance as quartz, or oxide of silicon, represents one member of the silicon family in relatively pure state. And a combination of carbon and silicon gives carborundum, hardest substance next to the diamond.

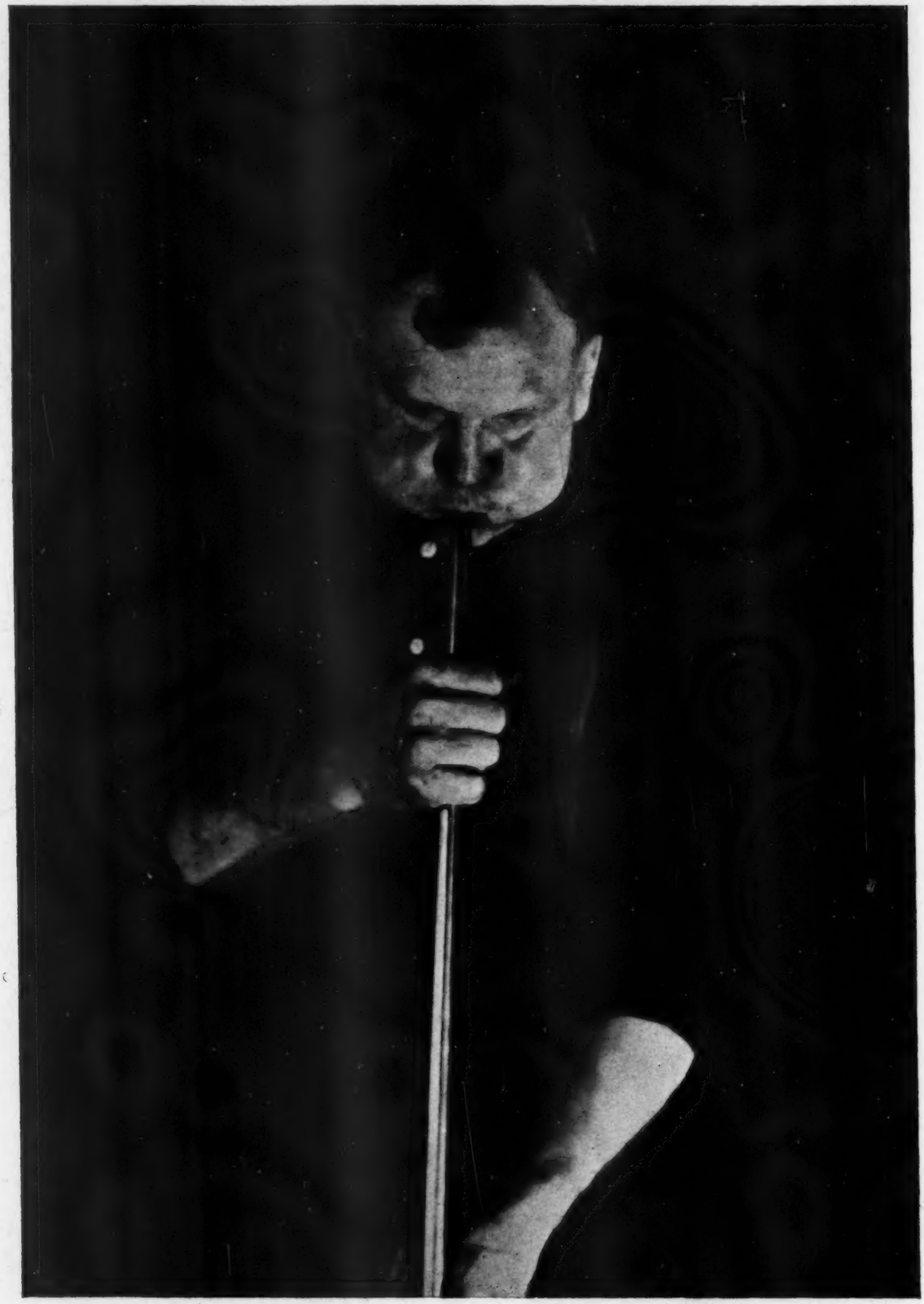
Now the glass maker probably does not take much interest in silicon, nor is it necessary that he should. Glass was made long before probing scientists discovered and labeled the silicon family. From the layman's standpoint, glass is made chiefly from sand. But sand is simply the crumbled fragments of rocks—that is silicon oxide in a conveniently powdered form. Children will probably never fall off to sleep under the impression that the SiO_2 Man is coming for them, but from a chemical standpoint the great sand-piles represent merely a usable and transportable silicon supply.

To the workmen in the glass factory, however, sand is simply sand, and plenty of it. Standing amid heaping dunes of white particles (like Cape Cod brought inland or a small section of the Sahara) the workman shovels them into a waiting hand-cart. A mask covers his mouth to keep the fine dust out of his lung. Other men, also grotesquely muzzled, trundle the cart into the mixing room. Here the sand is mixed with litharge or lime, with soda or potash or borax, and with any one or more of a hundred other ingredients depending upon the purpose for which the glass is intended. Originally sodium salts were obtained from sea water and potassium salts from wood ashes, but today these salts are obtained mostly from salt deposits. The largest deposit of potash salts is in Germany. During the war there was a shortage of potash outside of Germany and it was necessary to return to wood ash as a source. Since then, however, an adequate American supply has been obtained from Searles Lake in California. Sodium salts have always been very plentiful and the largest commercial consumers are obtaining their supply from so-called "salt wells" located in various parts of the United States.

After the batch has been properly made, it goes next to the furnace. Here, in the application of heat, is performed the major glass miracle—the transformation of opaque particles into a transparent solid. Silica, like the rest of the earth's crust, was formed by the cooling of the molten, liquid masses of which the interior of the earth is still composed. In its molten state, it is not only a liquid, but also a transparent liquid. So when the silica in the glass furnace is heated and melted, a transparent liquid results. And if, as in the glass factory, it cools off in the space of a few hours instead of through the centuries that it took the earth's crust to cool and solidify, it cools so rapidly that it is still transparent when it has become again solid. If it were left alone for a few hundred thousand years it might go back again to the rock whence it came.

The furnace tending job in the glass factory is much like the corresponding job in a steel mill. The sandy batch is cooked in clay pots or tanks, not only because clay can stand higher temperatures than steel, but also because there is some unexplained hostility between steel and silicon so

[1] By courtesy of *Fortune*, New York. Vol. 1, No. 1. 1930.



LIKE A MODERN GABRIEL SOUNDING HIS HORN, THIS WORKMAN PUFFS AWAY, EYES BULGING, CHEEKS DISTENDED. AND IT IS INDEED A LAST TRUMP HE IS SOUNDING—THAT OF HIS OWN TRADE. FOR HE IS A BLOWER OF GLASS, WHOSE CALLING HAS GONE THE WAY OF ALL CRAFTS BEFORE THE INVADING MACHINE

that when molten glass comes into contact with steel its surface becomes roughened and spoiled. Twenty-six days are spent in the building of a clay pot and six months in drying. Modern glass making is shifting away from the comparatively small, hand-built pots to large tanks with greater capacity and about a year's life.

Mixing and heating produce the transparent liquid from which glass is made. Shaping it is the glass-blower's business. It is an extremely hot business, because although molten glass is easily workable the cold glass is of course the familiar brittle substance through which boys so readily throw bricks. So the glass worker must work with his material still hot, as though the steel worker had to build a locomotive out of molten steel. Over the glass-blower's head is a ventilator to spray him with cool air. Water-cooled metal screens protect him somewhat from the withering heat which gradually crumbles the inside of clay pots eventually causing their discard. His mouth is ringed with tough flesh from long applications to blow-pipes. His palms are calloused from contact with hot irons. But he is a skilled worker, a well-paid worker, and he has the craftsman's pleasure in watching something shape itself under his hand.

The glass making itself is divided into two general operations—gathering the molten glass from the pot, then working

A SHOVELFUL OF SAND IN THE HANDS OF A BRAWNY WORKMAN IS THE GENESIS OF ALL GLASS

it into its final form. A young workman thrusts a long iron blow-pipe into the fiery pot. He twirls the pipe around to gather on it a blob of molten glass, like twirling a knife to

MASKED MEN WHEEL THE SAND TO THE MIXING ROOM

get honey out of a jar. Out comes the pipe, a glowing, viscous mass collected on its end. Then the pipe is passed to the master workman, who blows into it, twirls it in arcs like a bandmaster's baton, spins it deftly between his hands. He must work fast before the glass cools and hardens. His manipulations sprout on the end of the pipe a swelling growth of plastic glass which he places into a mold at his feet. When he or his helper has clamped the mold shut, he puffs into the pipe. The glass swells up inside the mold, taking on its final shape. The blower lifts it out, inspects it for flaws, puts the pipe with the finished glass still attached into a rack to cool down. Then he or a boy detaches the glass from the pipe and it is put on an endless belt on which it travels gradually from hot to cool temperatures.

The processes just described are essentially hand processes; the glass industry, indeed, from the time of the Egyptians and Phœnicians was dominated by the hand worker. Even as recently as 1900—a full century after the period generally covered by references to the "mechanical revolution"—the worker in glass had no machine competition. The industry in this country was virtually controlled by *Local* 300—a glass-workers' union which had built up a labor monopoly and dictated even to the glass manufacturers themselves. One manufacturer—the American Window Glass Company—put a $500,000 block of its stock in trust for the union and gave the union representation on its board of directors.

In 1908 came the introduction of the first glass-making

machinery—an innovation against which *Local* 300 sternly set its face. None of its members were permitted to work in plants where machinery was used; defiant, the union adopted an uncompromising *No Surrender* attitude toward the machine invasion. Instead of adapting itself to the machine (it might, for example, have extended its membership to the relatively unskilled machine-tenders) the union insisted that in the glass business, at least, the modern world should move at a mediæval pace. Eventually, of course, the machine triumphed. It learned to perform more and more of the operations formerly sacred to the handworkers' skill. By 1922 the tide had definitely turned toward the machine; by 1924 *Local* 300 had lost its position as wage-fixer for the industry; in 1927 the union made a belated and unsuccessful attempt to unionize unskilled labor; and in 1928 *Local* 300 disbanded. Said its president, in its obituary notice: "No human agency could have saved the handcraft . . . The mistake we made was in clinging to the old guild idea. That has no place in modern American industry."

Largest units in the glass industry today are Owens-Illinois Glass Co. of Toledo and the Pittsburgh Plate Glass Co. Owens-Illinois (whose merger with Continental Can Co. is indefinitely postponed) is in the container field, manufactures ink bottles, perfume bottles, druggists' bottles, bottles of every kind. It makes about 50% of the beverage bottles used by Canada Dry, White Rock and Clicquot. The Pittsburgh company (in which the omnipresent Mellons are interested) makes plate, window, spectacle and mirror glasses and a side line of paints, lacquers and solvents. In both companies the majority of operations are mechanical.

Thus, after some 5,000 years of unquestioned supremacy, the skilled Glass worker fought and, in 20 years, lost his battle with machinery. It should not, of course, be concluded that there is no skilled hand labor remaining in the glass business. Few industries become so thoroughly mechanized that the human element in the equation reaches the zero value of pulling a knob or turning a handle. Furthermore, there are many glass making operations in which the hand worker is still indispensable. Bottles and other ordinary containers; window-panes and other sheet products belong to the machine. But in the manufacture of laboratory apparatus, of decorative ware, of odd-shaped, non-standardized and small-volumed glass products, the glass-worker still follows the trade of his forefathers in much the way that they followed it. There exists, and there will always exist, a place for the skilled craftsman. But it is not the high place from which he so recently fell.

* * *

In the production of artistic glassware the craftsman still reigns supreme. The Corning Works have their Steuben division, where white-haired old glassmakers slowly mold and blow vases, bowls, candlesticks, and such decorative articles. But the center of modern glass craftsmanship is in France. There René Lalique, slender, trim-mustached, with the look of a scholar, is hard at work in his Paris atelier. He is drawing designs for every sort of object—bowls, perfume bottles, doorknobs, chandeliers, candelabra, intaglio seals, dinner plates—and all to be executed

THE POTS ARE SHOVED INTO BLAZING FURNACES

by his hundreds of glass craftsmen. From the two Lalique workshops, one at Fontainebleau and one in Alsace, flows an uninterrupted stream of vases, clocks, bottles, glasses, plates, picture frames, bowls, on which are etched or molded birds, beasts, flowers, fruits, fishes, nymphs, satyrs, and every sort of decorative device. The shops of Europe and America sell these products.

Commercially, René Lalique is as successful as any man in France. Yet he knows little of "business" and cares less. He willingly delegates all business matters to assistants. Occasionally he visits the shop in the Place Vendôme where the products of his two factories are sold, but he is more interested in what is being sold than in sales volume. He wanders from cabinet to cabinet, sharply examining the contents. Stopping in front of one, he carefully picks two small crystal figures out of it. He turns to the head of the shop: "These must be destroyed. Phone immediately to the factory, tell them to make no more of them and to destroy the molds. They are not good." Fortunate is the craftsman who works for such a master.

Steadily laboring in his Paris atelier, refusing to see most visitors and talking to those he does see of only one subject: his work, René Lalique turns out an amazing number of designs—enough to keep 600 men busy crystallizing them into glass. Their skilled hands and eyes and lungs are indispensable to their master. It would take a very clever machine to satisfy M. Lalique. It would have to execute his designs, which employ every sort of motif from frogs to rosebuds, and to execute them in the most delicate detail. It would have to mold and turn out unbroken the feathery tails of peacocks and the flowing robes of a wood nymph. It would have to etch a thousand and one designs on glass, sometimes lightly and sometimes in deep relief. And it would have to be able to change from one design to another as easily and quickly as a workman lays down one piece of work to pick up another—for M. Lalique wants none of that infinite repetition that is the chief strength of the machine.

Minor Alkali Metals

The United States Bureau of Mines, Department of Commerce has but recently issued a study of the minor or rarer metals. Incorporated in this are the characteristics of the elements caesium, rubidium, lithium, sodium and potassium the discovery of which was due in large measure to the spectroscope. Caesium was the first element discovered by the spectroscope and the others followed later on. Lepidolite, perhaps the best known of the lithium minerals is described as carrying a trace to more than 3 per cent of rubidium oxide and a small fraction of a per cent of caesium oxide. In the case of the latter there has been little demand for it, what use there has been being in the manufacture of radio tubes in which process it is introduced into the tubes in the form of chloride, mixed with magnesium or caesium, and is compressed into small tablets or "pills"; at one stage in the manufacture of the tube the pill is flashed, eliminating the least trace of air and thus securing the desired vacuum. The caesium chloride supplies positive ions at the surface of the filament.

Do Glass Tubes or Rods Bend Under Their Own Weight

In a letter to the editor of *Nature* (March 1, 1930) bearing the above title, Lord Rayleigh makes makes some interesting observations. He says:

> About seven years ago, in discussion with some scientific friends, I heard the opinion expressed that glass tubes, if stored upright, tend to bend permanently under their own weight. The same idea is to be found in print. Thus in Ostwald's "Physico-Chemical Measurements" (English translation, 1894, p. 66) we read that glass tubing "must be kept lying flat, otherwise it will become permanently curved."
>
> It seems difficult to reconcile this with the known fact that the annealing temperature of soft glass is somewhere about 500 C; but it was thought worth while to test the point directly. A glass rod 4.9 mm. (about $\frac{3}{16}''$) in diameter was laid across two nails about 1 metre apart on a brick wall, and loaded at the middle with 300 grams ($\frac{2}{3}$ lb.), which was judged to be near the limit of what it would safely bear. (In fact, after the experiment was concluded, it broke under test at 1060 grams.) The height of the mid-point was read on a mirror glass scale; the initial loading produced a depression of 2.8 cm. After that, for seven years there was no further movement large enough to be considered significant. Slight changes of reading were observed from time to time, but they were not systematic, and probably due to internal movements in the wall. The final reading was 1 mm. lower than the initial one. If we have regard to the last four years alone the net change of reading has been too small to measure.
>
> The stress applied in this experiment is very great compared with any that can be caused by the weight of the rod itself. It is therefore quite certain that glass of mature age does not bend in the way suspected. It is perhaps just possible that newly drawn glass may do so. RAYLEIGH.
>
> Terling Place, Chelmsford, February 18.

. . .

It is possible that some of our readers may be able to add something to the above note.

We have heard it stated that the glass in ancient cathedral windows in course of centuries has sagged and flowed, making the glass thicker at the bottom of a light than at the top. However, the evidence does not seem to be conclusive that the glass was not that way to begin with.

For our part, we have observed that most glasses devitrify readily at temperatures appreciably below those at which they flow perceptibly. We would accordingly suspect that any glass that was going to take a permanent set under its own weight would also devitrify. If the glass had not devitrified, we would suspect that any change of shape would be due simply to temperature changes, and of a temporary character. We would also suspect that when the devitrification had made some little progress, the crystal structure would confer on the glass an added resistance to flow and change of shape.—F. W. P.

The Rate of Crystal Growth in Technical Soda-Lime-Silica Glasses

By DR. ADOLF DIETZEL*

Translated by K. H. Lunde and F. W. Preston

Introduction and Review of Literature

IN the previous research[1] on the temperature-time-curves for the devitrification of plate glass, the exact determination of the speed of crystallization in a technical glass of the system soda-lime-silicic acid was fully described. With a composition of 70.15% SiO_2, 1.09% Al_2O_3, 0.21% Fe_2O_3, 15.62% CaO, 11.79% Na_2O, 0.16% K_2O, 0.14% As_2O_5, 0.84% SO_3, the circumstances attending the crystallization are comparatively simple, since at all temperatures, the maximum crystal length to be measured is that of one and the same crystal phase.

If we now proceed further to study, with the aid of the method thus developed, the subject of devitrification (in the form of individual crystals or of aggregates), throughout the whole technical field of the soda-lime-silica system, we run into a difficulty, which was touched upon in section 7 of the earlier research; in general, among industrial glasses, there will appear two sorts of crystals in juxtaposition, and the curves showing the rate of devitrification thereof will intersect each other in certain cases.

As a rule, cusped or notched curves are obtained, but these fulfill completely their technical purposes, inasmuch as they provide the glass technologist with information as to what he has to expect at any specified temperature and time, as regards the precipitation of troublesome individual crystals or of crystal aggregates.

Now, for practical purposes, it is of the greatest importance to know what change takes place in the behavior of a melt in respect of devitrification when we vary the proportions of soda, lime and silica. It is a well known fact that there is, within the ternary system of soda, lime and silica, a range of melts which in general presents no difficulty to the glass industry in its working. There can be no question, however, of laying down a definite boundary line within the three component system which shall separate a field of wholly glassy melts from the field within which devitrification occurs. A "limit-of-devitrification" in the exact sense must give information on the question whether a melt, subjected to any arbitrarily chosen, but exactly defined, time-temperature-treatment, will produce perceptible devitrification, and how large the crystals thereby precipitated will be. However, in the glass industry, conditions are not so simple that we could define any particular thermal treatment as normal for all cases; furthermore, there is no general agreement in the various branches of the glass industry as to what crystal length, or radius of spherulite, is to be considered as constituting perceptible devitrification.

The exceedingly varied thermal treatment of melts in the making of different categories of glassware (for example, cast plate glass, pressed ware, blown ware, window glass, etc.), constitutes a most serious handicap in laying down an exactly defined limit-of-devitrification. If one should draw a particular curve as the limit of devitrification in the triaxial diagram of soda-lime-silica, this boundary could only coincide with the devitrification limit in factory practice in the case of one, completely defined, variety of glass working.

The attempt has time and time again been made to lay down the practical limits of devitrification. In a treatise "On The Progress of The Glass Industry in Twenty-Five Years," R. Schaller[2] briefly outlines a diagram of the ternary system Na_2O-Ca O-SiO_2, in which he has drawn two lines of equal upper devitrification-temperature for 1,000° and 1,300° C. He understands thereby the temperature at which no appreciable crystal-precipitation is found in a test piece after heating for three hours. The two temperatures, 1,000° and 1,300° C., are chosen because the practical working range lies, in general, between these two temperatures.

The most important investigations of recent times in which the question of practical devitrification limits for industrial glasses of the soda-lime-silica series has been examined, start with the work of F. Gelstharp and J. C. Parkinson.[3] This has served hitherto, in industrial practice, as a guide for the choice of the lime content of the melt when the soda content is given. The diagram has already been discussed in some detail by E. Zschimmer (*Sprechsall* 57, 1924, p. 466).

C. J. Peddle[4] has given an outline of the devitrifying tendencies of certain soda-lime-silica glasses. He examined the molecular series 100 SiO_2 40 Na_2O O-40 CaO and 100 SiO_2, 20 Na_2O, O-40 CaO. His estimate of the tendency to devitrify was of a purely qualitative character since the melts were allowed to cool off from various temperatures to room temperature in the course of twelve hours and then the degree of devitrification was observed.

The most recent work in this field originates with E. Berger[5] He examined the five component system soda-potash-lime-alumina-silica, in respect of devitrification, by allowing the glasses in question to cool off in the experimental melting furnace. He then classified them according to the degree of resulting devitrification under the headings, "wholly glassy," "partly crystallized," or "wholly crystallized." This method is also, like the last, purely qualitative. All in all, it may be said that all previous studies on the circumscribing of a vitreous region in the soda-lime-silica system have limited themselves to defining visible devitrifi-

* A communication from the Silicate Laboratories of the Institute for Chemical Technology, Karlsruhe Technical School; published in Sprechsaal (Coburg) 1929.

[1] Die Temperatur-Zeit-Kurven der sichtbaren Entglasung bei Spiegelglas, Zschimmer and Dietzel, Sprechsaal 60. (1927) No. 7-12.

[2] Zeitschr. f. angew. Chemie, 22, 11, 1909, P. 2369.

[3] Transact. Amer. Ceram. Soc., Vol. 16, 1914, P. 109.

[4] J. Soc. Glass Techn., Vol. 4, 1920, P. 20.

[5] Glastechn. Berichte, 5, 1928, P. 569.

cation in more or less vague fashion. The practical devitrification limits pointed out by various experimentalists could only have significance for a particular sort of glass working (specified conditions of under-cooling); for there is no possibility whatever of showing clearly in a single diagram how glasses of different compositions behave during melting and working, in respect of the troublesome crystallization. A satisfactory solution of the problem from the point of view of the glass technologist can only be obtained through a set of diagrams which will give him exact answers to the two questions:

1. How big are the longest crystals in a given glass which has been held at a particular temperature for a particular time?

2. What influence has a change of soda, lime or silica, on the precipitation of crystals?

The making of a diagram that will answer the above questions for the technical field of the soda-lime-silica series constitutes the objective of the following work:

EXPERIMENTAL MATTERS

§ 1. Composition of The Glasses.

The technical field of the soda-lime-silica system may be mapped out by taking cross sections at right angles as in Table 1 where the compositions of glasses for investigation increase in steps of 2% in the oxide proportions.

TABLE 1

Theoretical oxide percentages of the melts examined.

No.	Na_2O %	CaO %	SiO_2 %
1	12	6	82
2	12	8	80
3	12	10	78
4	12	12	76
5	12	14	74
6	12	16	72
7	14	6	80
8	14	8	78
9	14	10	76
10	14	12	74
11	14	14	72
12	14	16	70
13	16	6	78
14	16	8	76
15	16	10	74
16	16	12	72
17	16	14	70
18	16	16	68
19	18	6	76
20	18	8	74
21	18	10	72
22	18	12	70
23	18	14	68
24	18	16	66

These compositions correspond with the following system of calcium oxide substitutions:

88% SiO_2 12% Na_2O → 6—16% CaO

86% SiO_2 14% Na_2O → 6—16% CaO

84% SiO_2 16% Na_2O → 6—16% CaO

82% SiO_2 18% Na_2O → 6—16% CaO

In a preliminary series of experiments, melts corresponding to the compositions of Table 1 where worked up in a platinum crucible containing 100 grams of glass and it was found thereby that the loss of soda in the firing process averaged .25%. Out of the 100 grams of molten glass amounted some 70% was obtained for experiments on devitrification. The raw materials were thoroughly mixed in the final stages with an agate mortar, in order to break up any remaining lumps of soda. The batch materials had the composition set forth in Table II.

TABLE II

Raw materials for making the melts and their percentage composition.

Dörentrup powdered rock-crystal "O B" quality

SiO_2... 99.86%
$Al_2O_3 + Fe_2O_3 + TiO_2$... 0.07%
Loss on ignition..... 0.07%

Burnt lime, Kahlbaum "Analytical" Na_2O..... 55.54%
H_2O..... 4.85%

Calcium Carbonate (precipitated) E. Merk CaO... 55.73%
Alkali.. 0.28%
Fe_2O_3.. 0.007%

2. The Melting Process and Obtaining Homogeneity.

For the melting process, a Fletcher furnace was used. The platinum crucible was placed freely in a guard crucible of fire-clay. The temperature of the surface of the glass could be approximately determined through a hole in the lid with a calibrated Holborn-Kurlbaum Pyrometer from Siemens & Halske.

The accuracy was of the order of ± 10° C. In order to prevent scattering and loss of dust from the batch in the process of filling on, the Fletcher furnace was first heated to about 1400°; then the air and gas were cut off and the platinum crucible, with its first fill, set in place. The batch sintered without loss of dust, this process taking not more than seven minutes in the case of the hardest glasses and only two minutes in the case of the soft ones, as determined by feeling them from time to time with a platinum rod. When this point had been reached, the blast was turned on and the glass completely fused in about ten minutes.

For the next fill, the platinum crucible, together with its guard crucible, was taken out of the furnace, and, after a short cooling in the open air, the second fill was added, and so on for subsequent fillings. When all the fillings, (as a rule, four in number) had been completed, there followed some twenty to twenty-five minutes of melting time at a temperature which lay at least 100 to 150 degrees higher than the equilibrium temperature at which, according to the diagram of Morey and Bowen, one finds the glass changing to crystal and vice versa.

In order to attain the necessary homogeneity, the glass was emptied out after the fusing process, pulverized in a steel mortar and remelted. The crushing of the glass was carried to such a point that all of it would pass through a sieve of .15mm aperture. After the remelting, the glass was poured out, pressed flat and the refractive index determined for small pieces from various parts of the melt after careful annealing. The result of the remelting may be illustrated by an example. For glass No. 7 having a composition of

80% SiO_2
14% Na_2O
6% CaO,

the index for the sodium line as measured, after the first melting, on various pieces, averaging about one-half centi-

meter square was found to be

n_D = 1.4998; 1.5008; 1.4995; 1.4993 (± 0.0003)
Average 1.4998

The maximum difference between the average and the single determination, therefore, amounts to .0010. The question is, how great are the differences of composition to which these variations of refractive indexes correspond? On this point we may, perhaps, make use of the table of O. Knapp,[6] according to which;

1% SiO_2	produces	an	alteration	of 0.01467
1% Na_2O	"	"	"	" 0.01575
1% CaO	"	"	"	" 0.01776

The refractive indices found above would, according to this, correspond in the most unsatisfactory cases with glasses of the following composition.

Homogeneous		Heterogeneous		
80.0	SiO_2	79.1	79.7	*80.0*
14.0	Na_2O	14.9	*14.0*	13.5
6.0	CaO	*6.0*	6.3	6.5

The differences found in the composition of melts of glass (of 100 grams) after a single remelting, were thus too great. A second melt was poured out, crushed, sieved and again melted and poured out. A determination of the refractive index gave for this glass,

n_D = 1.5005; 1.5002; 1.5000
Average 1.5002; Maximum difference 0.0003

These differences, apart from the fact that they fall within the limits of experimental error in determining the refractive index value, would correspond with the following variations in the composition of the glass;

Homogeneous		Heterogeneous		
80.0	SiO_2	79.72	79.9	*80.0*
14.0	Na_2O	14.28	*14.0*	13.85
6.0	CaO	*6.0*	6.3	6.15

Since the difference of .0003 from the average here observed was also the worst variation measured among the remaining glasses, this degree of homogeneity appears to be sufficient. As appeared later in the measuring of the devitrication specimens, the variations from specimen to specimen lay within the experimental error.

Accordingly, all of the masses were, after the first teeming, crushed and remelted, then again poured out and quenched in the same fashion as after the first melting. The resulting fragments served for the experiments on devitrification and for analysis.[7]

§ 3. Analysis of the Glasses.

In all, twenty-four melts were analyzed. Soda, lime, and the sum of alumina, ferric oxide, platinum, etc., were determined by solution in hydrofluoric acid and the silica determined by difference. For some glasses, the iron oxide content was determined; it varied between .05 and .09 per cent. The results are given in table 3 below. The soda, (Na_2O) content was raised 0.25% in comparison with the theoretical values in order to attain as closely as possible the percentages set out in Table 1 above.

TABLE III

Analyses of the Melts Corrected by the Addition of Soda

	Na_2O	CaO	SiO_2	Al_2O_3 Fe_2O_3
Glass 1 Calculated from batch	12.25%	6.00%	82.00%	0.08
As Analyzed	11.87	6.01	81.97	0.15
A—C	—0.38	+0.01	—0.03	+0.07
Glass 2 Calculated from batch	12.25	8.00	80.00	0.08
As Analyzed	11.90	8.05	79.90	0.15
A—C	—0.35	+0.05	—0.10	+0.07
Glass 3 Calculated from batch	12.25	10.00	78.00	0.08
As Analyzed	11.90	8.05	79.00	0.15
A—C	—0.32	+0.01	—0.07	+0.05
Glass 4 Calculated from batch	12.25	12.00	76.00	0.08
As Analyzed	11.99	12.05	75.72	0.24
A—C	—0.26	+0.05	—0.38	+0.16
Glass 5 Calculated from batch	12.25	14.00	74.00	0.07
As Analyzed	11.95	14.01	73.90	0.14
A—C	—0.30	+0.01	—0.10	+0.07
Glass 6 Calculated from batch	12.25	16.00	72.00	0.07
As Analyzed	12.05	16.07	71.67	0.21
A—C	—0.20	+0.07	—0.33	+0.14
Glass 7 Calculated from batch	14.25	6.00	80.00	0.08
As Analyzed	13.87	6.05	79.87	0.21
A—C	—0.38	+0.05	—0.13	+0.13
Glass 8 Calculated from batch	14.25	8.00	78.00	0.08
As Analyzed	14.05	8.03	77.68	0.24
A—C	—0.20	+0.03	—0.32	+0.16
Glass 9 Calculated from batch	14.25	10.00	76.00	0.08
As Analyzed	13.95	10.02	75.82	0.21
A—C	—0.30	+0.02	—0.18	+0.13
Glass 10 Calculated from batch	14.25	12.00	74.00	0.07
As Analyzed	13.93	12.01	73.94	0.12
A—C	—0.32	+0.01	—0.06	+0.05
Glass 11 Calculated from batch	14.25	14.00	72.00	0.07
As Analyzed	14.03	14.06	71.65	0.26
A—C	—0.12	+0.06	—0.35	+0.19
Glass 12 Calculated from batch	14.25	16.00	70.00	0.07
As Analyzed	13.97	15.98	69.92	0.13
A—C	—0.28	—0.02	—0.08	+0.06
Glass 13 Calculated from batch	16.25	6.00	78.00	0.08
As Analyzed	15.92	5.98	78.95	0.15
A—C	—0.33	—0.02	—0.05	+0.07
Glass 14 Calculated from batch	16.25	8.00	76.00	0.08
As Analyzed	15.95	8.10	75.85	0.10
A—C	—0.30	+0.10	—0.15	+0.02
Glass 15 Calculated from batch	16.25	10.00	74.00	0.07
As Analyzed	15.97	10.08	73.76	0.19
A—C	—0.28	+0.08	—0.24	+0.12
Glass 16 Calculated from batch	16.25	12.00	72.00	0.07
As Analyzed	15.93	12.02	71.84	0.21
A—C	—0.32	+0.02	—0.16	+0.14
Glass 17 Calculated from batch	16.25	14.00	70.00	0.07
As Analyzed	15.96	13.97	69.93	0.14
A—C	—0.29	—0.03	—0.07	+0.07
Glass 18 Calculated from batch	16.25	16.00	68.00	0.07
As Analyzed	16.00	16.02	67.71	0.27
A—C	—0.25	+0.02	—0.29	+0.20
Glass 19 Calculated from batch	18.25	6.00	76.00	0.08
As Analyzed	17.94	6.01	75.89	0.16
A—C	—0.31	+0.01	—0.11	+0.08
Glass 20 Calculated from batch	18.25	8.00	74.00	0.07
As Analyzed	18.05	8.05	73.79	0.11
A—C	—0.20	+0.05	—0.21	+0.04
Glass 21 Calculated from batch	18.25	10.00	72.00	0.07
As Analyzed	17.91	10.07	71.73	0.29
A—C	—0.34	+0.07	0.27	0.22
Glass 22 Calculated from batch	18.25	12.00	70.00	0.07
As Analyzed	18.00	12.03	69.73	0.24
A—C	—0.25	+0.03	—0.27	+0.17

[6] O. Knapp, Glass Industry, Vol. 8 (1927) P. 73.

[7] For comparison, the melt containing 72% silica, 18% soda and 10% lime, was stirred up three times for periods of five minutes with a platinum rod instead of being remelted. After being poured out, fragments were taken as before from various parts of the melt and the refractive index determined, so as to decide the degree of agreement among themselves just as in the case of the remelted glasses previously mentioned. The stirring process was, however, too lacking in precision for the general run of melts in the absence of any mechanical device for the purpose. It was, therefore, in general, not used.

	Na_2O	CaO	SiO_2	Al_2O_3 Fe_2O_3
Glass 23 Calculated from batch	18.25	14.00	68.00	0.07
As Analyzed	17.97	14.06	67.78	0.19
A—C	—0.28	+0.06	—0.22	+0.02
Glass 24 Calculated from batch	18.25	16.00	66.00	0.07
As Analyzed	17.95	15.97	65.83	0.25
A—C	—0.30	—0.03	—0.17	+0.18

§ 4. Simplified Methods for the Determination of the Rate of Crystallization.

The manner in which the rate of crystallization ("Kristallisations-geschwindigkeit," which Dietzel abbreviates to KG, in which form it appears in the diagrams reproduced herewith) was determined for the various glasses, corresponds in a general way with the method described in the earlier work, "On the Temperature-time-curves for the Devitrification of Plate Glass." It was possible, however, to introduce some simplifications.

In the majority of melts two compounds crystallized out; it was necessary to determine the rate of crystallization for each compound at least within the range of temperature wherein the longest crystals are produced. The individual crystals were most readily inspected in the surface of the sample and less easily in a thin section. In the latter case the crystals were so awkwardly sectioned that a satisfactory determination of the two varieties was impossible. However, it was possible readily enough to do this by examination between crossed nicols. (c. f. 1a and 1b.)

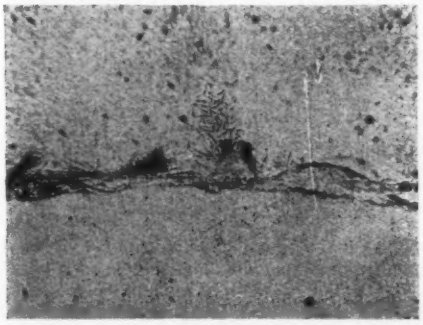


FIG. 1a.
NICOL II

FIG. 1b.
NICOL+

In general thin sections were used only when the crystals were so thickly matted together that individual crystals were impossible to measure, but in some instances, more especially in the soda-rich and lime-poor melts, special care was taken, to the extent of measuring up thin sections. A comparison of the lengths as measured by the direct observation of the test samples with those obtained from the thin sections, showed that the last mentioned came out much too low. Evidently crystals (of a flaky or tabular habit) grow comparatively broad in the surface layers and comparatively slowly at right angles thereto, towards the interior of the glass.

The length of the crystals lying in the surface was determined with a Zeiss microscope and an ocular micrometer.[8]

A further simplification was made possible through the determining of the temperature of equilibrium between crystal and glass. In order to avoid extravagantly long times of devitrification in the neighborhood of this point, a sample was taken, in the case of a few glasses, in which crystals about 100 μ in length had been formed by holding some fifty degrees below the limit-of-devitrification as determined by Morey and Bowen. Then the sample was heated for ten minutes at temperatures stepped up in intervals of ten degrees from this point. Before each further rise of temperature the sample was taken out of the platinum crucible and the crystals examined under the microscope. The stepping up of the temperature was continued until the contours of the crystals showed signs of rounding or became hazy; in the next step-up of temperature, the phase boundary was crossed sharply. The exact determination of the equilibrium temperature was carried out in similar fashion except that the temperatures within the critical ten degrees was raised in steps of two degrees each.[9]

A preliminary experiment was made to determine approximately the time needed to get crystals of 300 μ in length and then as a rule four further samples were treated at this same temperature, and the rate of crystallization for this temperature was calculated from average of the maximum crystal length observed in the four samples and the elapsed time.

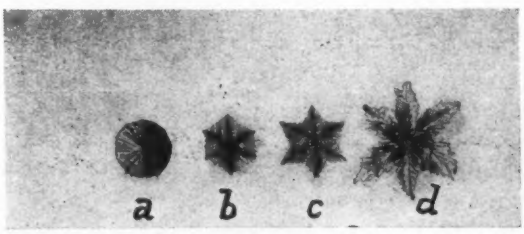


FIG. 2

§ 5. Identification of the Crystal Phases Formed.

In the field of the soda-lime-silica system covered, the following five varieties of crystals appeared as devitrification products.

1. Cristobalite (SiO_2)
2. Tridymite (SiO_2)
3. Wollastonite (b—$CaSiO_3$)
4. Pseudowollastonite (a—$CaSiO_3$)
5. Na_2O, 3 CaO, 6 SiO_2

There was no difficulty about determining the first three compounds namely:

[8] The devitrification samples (for the most part small cones) were fastened with wax on the edge of a microslide for measuring purposes.

[9] According to a private communication from Dr. H. W. Morey to the author, much the same procedure was employed by Morey and Bowen in their determination of the equilibrium temperature.

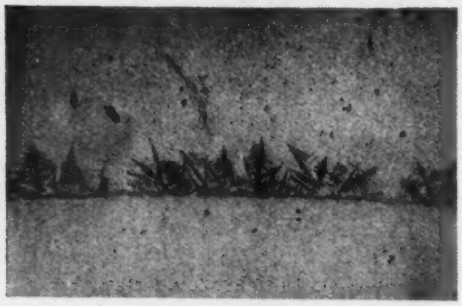


FIG. 3a CRISTOBALITE

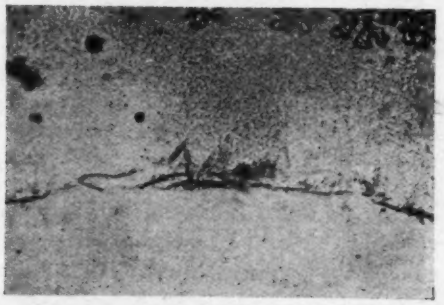


FIG. 3b

FIG. 3c

FIG. 4. TRIDYMITE, MIXED WITH WOLLASTONITE

Cristobalite, in the form of the typical Christmas tree, needle or plate[10] (c. f. Fig. 3-a-b and c), with a low double refraction.

[10] The platey forms, which only arise in the softer glasses and at relatively low temperatures (700 to 900 degrees) take the form illustrated in Figs. 2a, b and c. On allowing longer time for devitrification, forms 2b and c developed into the feathery or fern-like structure of 2d, while form 2a retained its radially fibrous character. We therefore suspected here another compound (quartz or sodium tricalcium silicate); however, the refractive index of the flakes observed was lower than that of the glass which produced it, indicating cristobalite (or tridymite). Further, in the thin sections referred to, only cristobalite was to be found.

Tridymite, in the form of hexagonal flakes with low double refraction; this appeared only sporadically and as very small crystallites (c. f. 4).

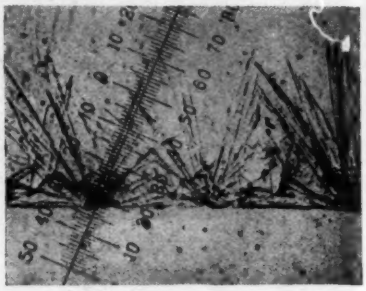


FIG. 5a. WOLLASTONITE NEEDLES

FIG. 5b. WOLLASTONITE BRUSHES

Wollastonite, strongly doubly refracting, in long needles mostly associated into brushes as in Figs. 5a and 5b.

The determination of the third and fourth varieties was somewhat more difficult. (Apparently Dietzel means the fourth and fifth varieties—F. W. P.)

Pseudowollastonite formed in association with wollastonite in small hexagonal plates, in part apparently elongated (Fig. 6). This could be distinguished from the other compounds by the positive character of its birefringence.

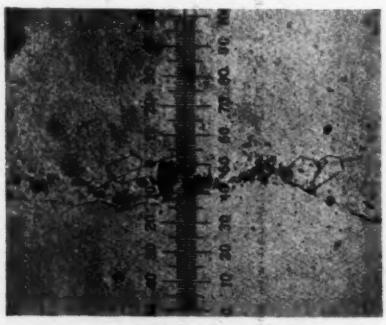


FIG. 6. PSEUDOWOLLASTONITE

The double silicate $Na_2O.3\ CaO.6\ SiO_2$ could not be identified by microscopic examination of the melts, but showed up readily enough in the X-ray analysis. For identification purposes Debye-Scherrer pictures were taken, in the X-ray laboratory of the Stuttgart Technical School, of the following devitrification samples.[11]

[11] In order to produce the greatest possible number of nuclei of devitrification, no large pieces, but only glass dust, was devitrified for this purpose.

FIG. 7

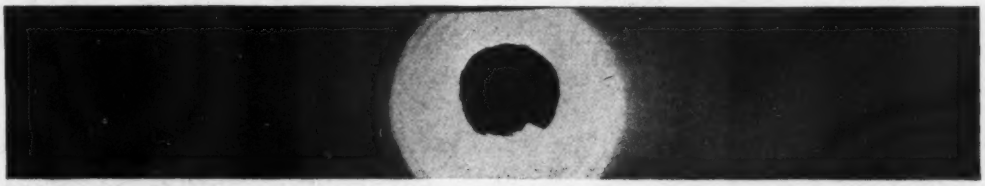


FIG. 8

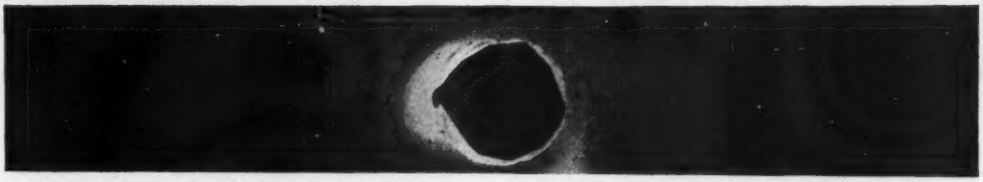


FIG. 9

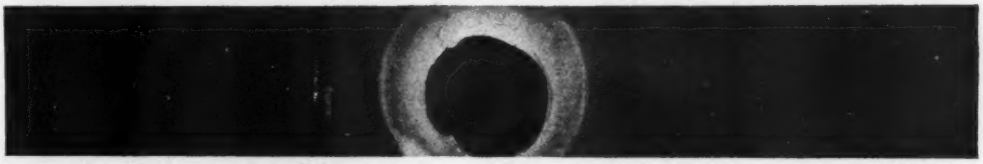


FIG. 10

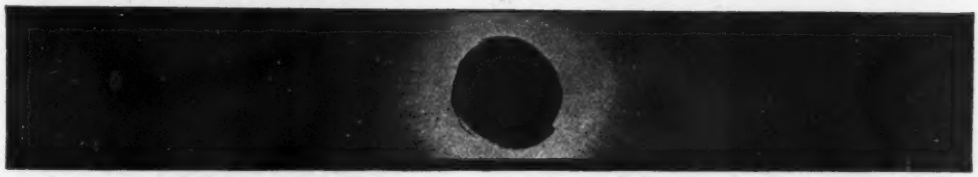


FIG. 11

FIG. 12

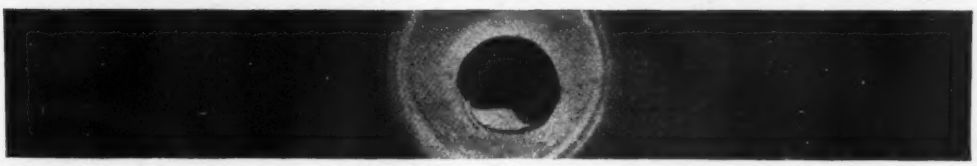


FIG. 7. X-RAY PATTERN GLASS NO. 15—875°. FIG. 8. X-RAY PATTERN GLASS NO. 15—925°. FIG. 9. X-RAY PATTERN CRISTOBALITE. FIG. 10. X-RAY-WOLLASTONITE. FIG. 11. X-RAY—PSEUDOWOLLASTONITE. FIG. 12. Na_2O, 3 CaO, 6 SiO_2

Glass No. 15 at 875° for 30 minutes
Glass No. 15 at 925° for 30 minutes

The Röntgen pictures are produced in Figs. 7 and 8. The apparatus and method was the same as that described in the earlier work.[12]

For comparison there were used interference patterns of Cristobalite (Fig. 9) Natural Wollastonite (Fig. 10) Pseudowollastonite (Fig. 11) (made from Wollastonite) and the double silicate $Na_2O.3$ CaO.6 SiO_2 (Fig. 12) which was prepared according to the method of Morey and Bowen.

It appeared that at the lower temperature (875° C.) Cristobalite and the double silicate crystallized out, whereas at 925° Cristobalite and Wollastonite appeared.

As a precautionary measure, some melts outside of the field at present under investigation were made and devitrified, which, according to Morey & Bowen, precipitate the following compounds: Quartz; Na_2O, 2 SiO_2; Na_2O, 3 CaO, 6 SiO_2; and Na_2O, 2 CaO, 3 SiO_2. The crystal forms observed herein could not be found by microscopic examination in the devitrification specimens of the field considered in this research.

§6. Appearance of the Devitrification Product and Results of the Measurements

As was well brought out in the earlier work, the first crystals form at the surface of the specimens.[14]

In the following table the results of the measurements are tabulated and any noteworthy phenomena described and illustrated with photomicrographs. If more than one variety of crystal appeared in a glass, the lengths of each compound were measured and recorded separately in the corresponding

[12]Zschimmer & Dietzel, Sprechsaal 1927, 60, 110.

table. From crystal length at the various temperatures and from the time allowed for devitrification, the rate of growth in μ/minute was calculated. The dependence of the rate of growth upon the temperature has in each case been illustrated in a diagram appended to the table.

In addition, for each glass, the temperature is given and marked with a cross upon the diagram, whereat the specimens after each experiment had taken the conical form of the platinum crucible; this may be called the softening temperature of the specimen. We shall return later to this phenomenon of viscous flow.

GLASS No. 1

Na_2O 11.87%, CaO 6.0%, SiO_2 81.99%, Al_2O_3 etc. 0.15%

TABLE IV.

Devitrification Temp. °C.	Devitrification Time (Minutes)	Resulting Crystal Length (μ) 1μ=.001 mm.	Average	Rate of Growth μ/minute	Crystal Phase Precipitated
1000°	10	435 445 445	442	44.2	Cristobalite
1100°	5	505 410 412	409	82.0	
1200°	5	435 445 447	442	88.0	
1300°	5	174 176 171 180	117	35.5	

Temperature of the Most Rapid Growth, 1175° C.
Maximum Rate of Growth 89 μ/minute.
Softening temperature of the glass samples 1100° C.

Below 1200° the crystals were so thickly matted together that their length had to be determined in thin section. The photomicrograph of Figs. 13 to 18 show the precipitation at 900° C. (Fig. 13), 1000° (Fig. 14), 1100° C. (Fig. 15), 1150° (Fig. 16), 1200° (Fig. 17), 1300° (Fig. 18). The curve showing the connection between rate of devitrification and temperature is given in Fig. 19.

[14]And also on the surface of entrapped gas bubbles.

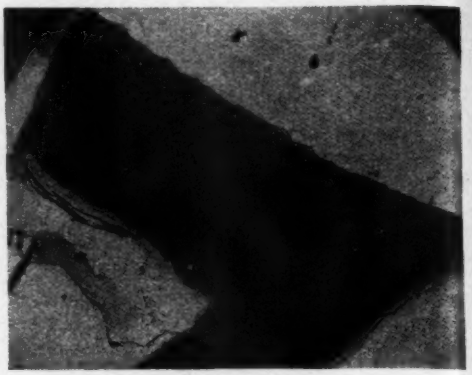


FIG. 15—1100°

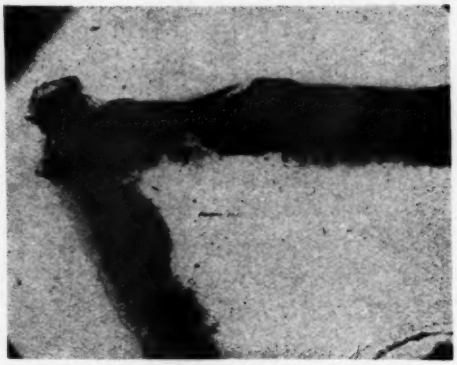


FIG. 16—1150°

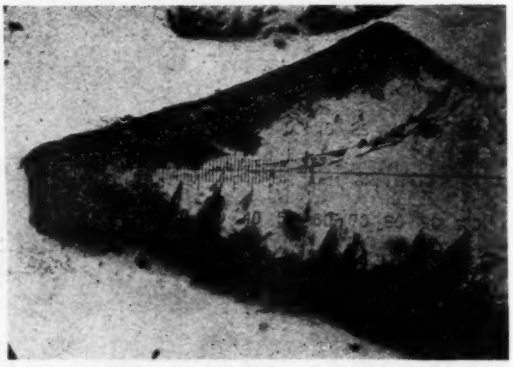


FIG 17—1200°

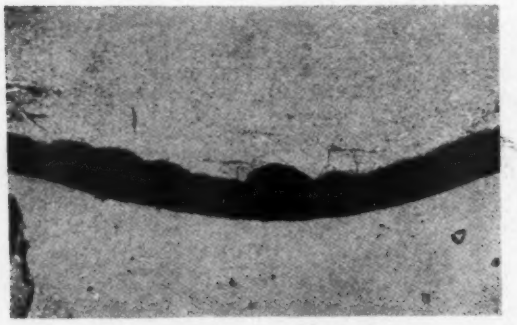


FIG. 13. GLASS NO. 1—900° C.

FIG. 18—1300°

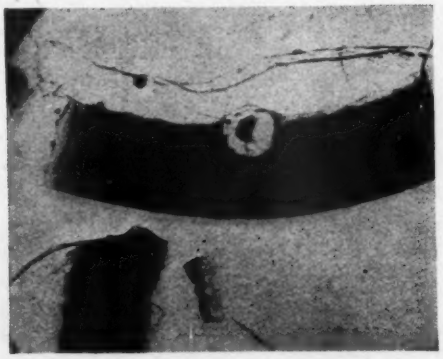


FIG. 14—1000°

GLASS No. 2

Na_2O 11.90%, CaO 8.05%, SiO_2 79.90, Al_2O_3 etc. 0.15%

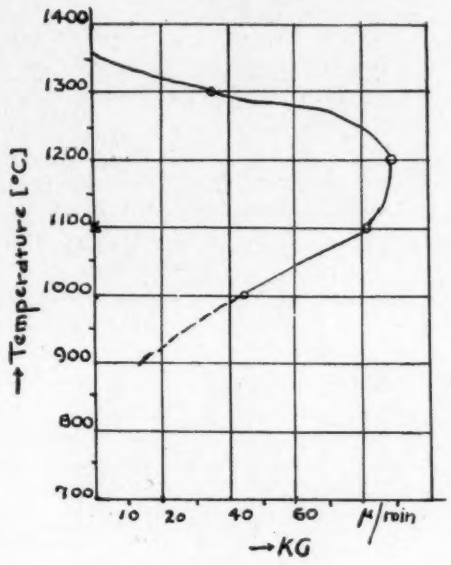


FIG. 19

TABLE V.

Devitrification Temp. °C.	Devitrification Time (Minutes)	Resulting Crystal Length (μ) 1μ=.001 mm.	Average	Rate of Growth μ/minute	Crystal Phase Precipitated
900°	15	177 182 185	181	12.0	Cristobalite
1000°	5	158 158 165	160	32.0	
1100°	5	265 269 275 275	271	54.2	
1200°	5	208 215 218 220	215	43	

Temperature of Most Rapid Growth 1140° C.
Maximum Rate of Growth 56 μ/minute.
Softening Temperature of Glass Samples 1050° C.
For Curve see Figure 20.

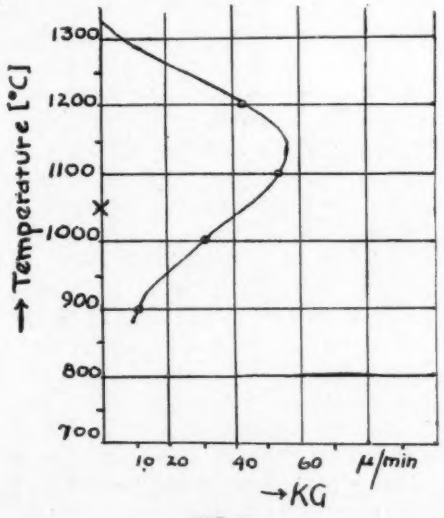


FIG. 20

GLASS No. 3

Na_2O 11.93% CaO 10.01%. SiO_2 77.92%, Al_2O_3 etc. 0.13%

TABLE VI.

Devitrification Temp. °C.	Devitrification Time (Minutes)	Resulting Crystal Length (μ) 1μ=.001 mm.	Average	Rate of Growth μ/minute	Crystal Phase Precipitated
910°	10	68 70 75	72	7.2	Cristobalite
	20	150			
1010°	5	92 88 102 105	99	19.8	
1100°	5	200 205 207	204	40.1	
1150°	5	205 208 215 210	209	42	
1200°	5	95 100 110 110	104	21	

Temperature of most rapid growth 1130° C.
Maximum Rate of Growth 43 μ/min.
Upper limit of Devitrification 1252° C.
Softening Temperature 1000°.
For curve see Fig. 21.

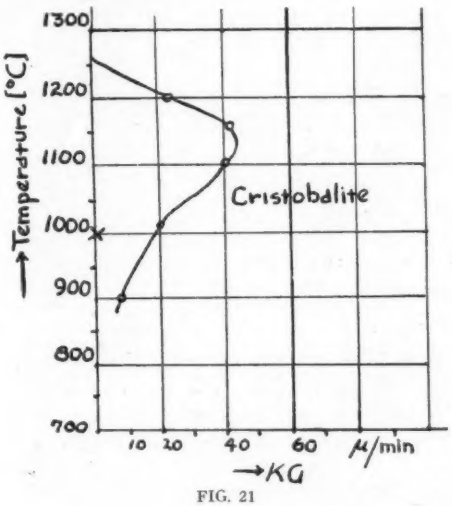


FIG. 21

(To be continued)

Urges Speed to Complete Census of Manufactures

The Advisory Committee on the Census of Manufactures appointed by the Secretary of Commerce and consisting of twenty-five prominent men connected with various industries and business organizations, is urging manufacturers and business men who have not completed their census schedules to fill them in immediately. Delay in doing so postpones the date at which the completed returns can be published and consequently lessens their value to the manufacturers themselves.

The questions are practical; the information they call for is regularly kept by many concerns in monthly or annual routine records. Replies to them will enable those interested to compare their own results with the entire industry, for example, on total output in detail by quantities and value, number of dollars of output per earner, and cost of materials. Changes from the previous census will be noted.

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Devitrification

In this issue of THE GLASS INDUSTRY we begin the publication of an important recent German paper on the subject of devitrification. This will be completed in several installments. We hope to maintain a series of translations in order that there may be available to English speaking peoples an adequate library in the English language of the more important foreign researches in the glass field.

We have taken the opinion of many representative American workers, and believe that there is need for some such arrangement. A real gap exists in the organization of the glass industry in this respect, for only abstracts of foreign work are in general available, and the majority of American and English workers rarely read, still less enjoy, technical German. Consequently an understanding of foreign work is somewhat slowly acquired by the industry as a whole.

The volume of foreign publications, particularly German material, is so large that it will be quite impossible to translate more than a small fraction of it. It is not likely that we can satisfy all needs, or that our choice of articles will in all cases be those having the greatest permanent value, or the greatest momentary interest. We hope, however, to suit as many of our readers as possible, and shall be glad to receive suggestions as to our readers' preferences.

In choosing Dr. Dietzel's paper for the present issue, we have been guided by the following considerations:—(1) it seems to cover definitely new ground. (2) It reaches definite quantitative conclusions and is free from vagueness. (3) It is readily comprehensible to men in the shops as well as to those in laboratories. (4) It is well illustrated, in many cases by excellent photographs and by clear diagrams. (5) It relates to a subject familiar to all glass men, for all of us are bothered from time to time by problems of devitrification.

We hope that our readers will approve our policy.

The Trans-Neptunian Planet

THE recent discovery of this very remote member of the solar system is one more reminder of the intimate connection between the glass industry and the progress of pure science. The new planet is reported as of the fifteenth magnitude; that is to say it is utterly beyond the reach of the unaided eye, and its discovery needed some excellent glasswork to make it possible.

On the material side, this is an age of steel; on the spiritual side it is an age of glass. The advance of science in recent years has depended very largely on the development of those powerful tools, the telescope, microscope, and spectroscope, whose essential elements are made of glass. In fact it may be said with a fair approximation to the truth, that the cornerstone of modern civilization is the lens. By its aid the confines of the universe are pushed back, and with its aid the structure of the atom is laid bare. With its help, too, much of the progress in modern biology and medicine has been made possible. Perhaps it would not be too much to say that the world might lose its steel industry with nothing worse than a considerable inconvenience, but the loss of the glass industry would carry civilization with it; for where there is no vision the people perish.

Death Takes Our Technical Editor

To Our Readers:

We have a profoundly sorrowful duty to perform—that of informing our readers of the death of our much beloved Technical Editor, J. B. Krak, who suddenly passed out of the world of the living on Sunday, April 6, at a hospital in California. Mr. Krak had been undergoing treatment since last fall following a breakdown in his health which occurred last summer.

During his connection with the glass industry which extended, with one or more temporary interruptions, over a score of years, Mr. Krak had made a host of friends throughout the country who will feel deeply the loss of a man who was not only a glass technologist of great ability but also possessed many attractive personal qualities, a strong and admirable character, a broad intellectual outlook, and who was the soul of integrity.

He was earnestly devoted to the interests and advancement of the glass industry in general and his editorial work was a labor of love—not in any sense a commercial proposition. Those friends who have had personal contact with him and many others who are familiar with his accomplishments will feel that the industry has been deprived of a most capable, valuable man.

JAN BERGHUIS KRAK

Jan Berghuis Krak was born at Amsterdam, Holland, March 27, 1884. His parents were Louis Charles Krak and Christine Veefkind Krak. He was educated at public schools in Holland and took a five-year course in the Boys' High School at Amsterdam. There he specialized in chemistry and when finished went to Wiesbaden, Germany, to study chemistry in the famous laboratory of Dr. Fresenius, whose assistant he became.

In 1907 he came to the United States, holding first a position as chemist, near New York. After awhile he severed that connection and went to the University of Illinois where he was employed as a chemist. From there he went to Morgantown, West Virginia, following an appointment on the West Virginia State Geological Survey. While at Morgantown he took courses in the University of West Virginia and received the degree of bachelor of science. During the war he began to experiment with chemistry in connection with the glass industry. He was successful in solving many serious technical and manufacturing problems and was frequently employed by glass factories located along the Monongahela River and adjacent territory as a consultant. Those for whom he did such work have spoken in the highest terms of his ability and reliability and emphasized the fact that his solutions of problems were always of a practical character as well as theoretically correct, and not inapplicable to factory practice as is sometimes the case with a young chemist.

He left Morgantown to become a chemist for the General Chemical Company at their plant in Long Island City, New York. He lived at that time in Jamaica, New York. Later he joined the staff of the laboratory at the Union Carbide Company at Niagara Falls, New York.

Early in 1921, shortly after THE GLASS INDUSTRY was established Mr. Krak began to write on subjects related to glassmaking and in September of that year his appointment as Technical Editor was announced. He found great enjoyment in his editorial work and labored faithfully at it until ill health compelled him to relax his efforts. Through his work on the paper and his other activities in the glass field he became well and very favorably known throughout the industry, especially for his practical aid to glass manufacturers who were adopting scientific methods in glassmaking processes in preference to the old "rule of thumb" practices which still persisted in the majority of glass factories up to recent times. He not only advocated these principles in his writings but practiced them in connection with his own work in the glass manufacturing field and better glass is undoubtedly being made today in many American glass plants because of his untiring efforts to induce glass makers to use scientific methods.

The Roessler & Hasslacher Chemical Company became interested in his attainments and after carrying out an arrangement made for a two months' tour of glass factories in Europe, he was appointed on his return to the United States to be glass technologist at the experimental station in their Perth Amboy plant.

In the summer of 1929 he gave up most of his active work on account of ill health and went to stay with a brother in California in the hope of recuperating his strength. While it was generally known that Mr. Krak's health had been seriously affected his recovery ultimately was looked forward to. His sudden passing was unexpected by his relatives and friends who have been greatly shocked by the news.

Mr. Krak's wife survives him and also remaining are his mother, Mrs. Christine V. Krak of The Hague, Holland, three brothers, Oeds B. Krak of San Jose, California, Henry B. Krak of The Hague, Louis B. Krak, New York City, and two sisters, Marie B. Krak, Albany, N. Y., and Louise B. Krak of The Hague.

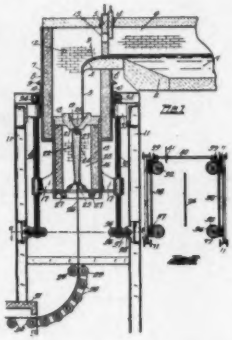
The EDITOR.

Recent Patents

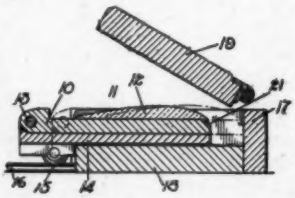
NEW INVENTIONS DESIGNED TO IMPROVE GLASS AND THE MEANS OF PRODUCING IT

Complete copies of U. S. Patent Specifications may be obtained from the Commissioner of Patents, Washington, D. C., Price 10c each

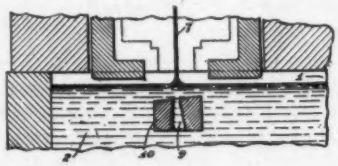
METHOD AND APPARATUS FOR FORMING SHEET GLASS. U. S. 1,753,768. April 8, 1920. James C. Blair, Toledo, O., assignor to Libbey-Owens Glass Company, Toledo, O. Filed 4/25/24. According to the present invention means are provided for adjusting vertically the entire sheet-forming portion of the mechanism as a unit, without varying any of the sheet-forming conditions except the weight of the suspended portion of the sheet. More specifically, the sheet-forming slab, and a hopper or receptacle for catching the downwardly flowing stream of molten glass, are arranged in relatively fixed positions within an enclosing housing which is adjustable vertically through a rather long range of travel. This housing has telescopic connection with an upper fixed housing surrounding the downwardly flowing stream of molten glass, so that the molten stream and the sheet-forming mechanism are always completely enclosed and the temperature conditions therearound remain substantially constant. By adjusting this sheet-forming means vertically the mass of the suspended sheet is varied to secure the desired drawing force. At the same time the vertical fall of the stream of molten glass will be varied, but this is of no consequence since the stream is first caught in the distributing hopper, which will normally contain a small pool of the molten glass of substantially constant volume, the molten glass flowing from this pool at a constant rate onto and around the sheet-forming slab. The adjusting mechanism also provides an easy means for providing access to the distributing hopper and sheet-forming slab when it becomes necessary to repair or replace these parts.



METHOD FOR PRODUCING SHEET GLASS. U. S. 1,753,779. April 8, 1930. Enoch T. Ferngren, Toledo, O., assignor to Libbey-Owens Glass Company, Toledo, O. Filed 11/1/24. An object of the invention is to produce a sheet of glass wherein a quantity of molten glass is pressed between surfaces of preferably non-corrosive alloy members to form a flat sheet which may be vertically run through a suitable chamber to fire-polish first one side and then the other to give a sheet having fire-polished surfaces.

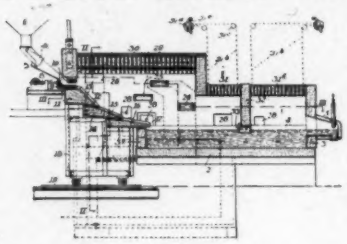


APPARATUS FOR DRAWING SHEET GLASS. U. S. 1,753,291. April 8, 1930. Howard L. Halbach, Clarksburg, W. Va., assignor to Pittsburgh Plate Glass Company. Filed 4/4/28. The provision of improved means for equalizing the temperature of the glass in the bath on the opposite sides of the sheet being drawn from the forehearth or drawing tank. In such a tank, which communicates at one end with the melting tank, there is a tendency for the glass on the side of the drawbar nearest the melting tank to run at a higher temperature than that of the glass on the far side of the drawbar. The inventor has found it possible to counteract this tendency by the construction of the drawbar, two novel features contributing to this result, one being the location of the slot off center with respect to the center line of the bar, and the other being the inclination of the top of the bar.



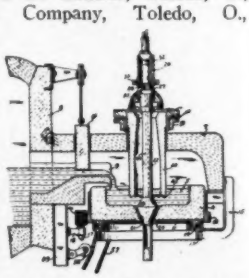
LAMINATED GLASS AND METHOD FOR PRODUCING THE SAME. U. S. 1,751,051. March 18, 1930. William E. Nobbe, Toledo, O., assignor to Libbey-Owens Glass Company, Toledo, O. Filed 1/28/28. In the production of laminated glass, in accordance with the present invention, a plurality of individual sheets of non-brittle material are interposed preferably between two relatively larger sheets of glass, the said individual sheets of non-brittle material being arranged side by side with their adjacent edges preferably abutting or substantially abutting one another. The glass sheets are then adapted to be united with the several individual sheets of non-brittle material simultaneously to form a large composite sheet or unitary structure, after which the glass sheets are cut between the adjacent non-brittle sheets of material so as to produce a plurality of individual composite sheets. Prior to the uniting of the several sheets, however, the adjacent surfaces thereof are preferably coated with a suitable bonding material to aid in the uniting thereof.

METHOD AND APPARATUS FOR MELTING GLASS AND THE LIKE. U. S. 1,751,987. Mar. 25, 1930. Robert L. Frink, Lancaster, O. Filed 10/8/26.



2. The method of making molten glass-like material which includes subjecting constituent material to a melting temperature on a support preferably inclined, while maintaining it in a relatively thin and spread out condition, substantially continuously advancing the material during the melting step at a substantially uniform rate at all points of travel, and collecting the melted material in a pool.

METHOD OF AND APPARATUS FOR FORMING GLASS TUBING. U. S. 1,750,972. March 18, 1930. Leonard D. Soubier, Toledo, O., assignor to Owens-Illinios Glass Company, Toledo, O., Filed 2/16/27. The method of forming glass tubing which consists in causing molten glass to flow vertically from a solid mass of molten glass in a container, constantly supplying fresh glass to the container, continuously rotating the entire mass of glass in the container about an axis coincident with that of the vertically flowing tubing, continuously applying a movement retarding force to portions of the glass in proximity of the axis of rotation, and giving the tubing its final shape substantially at its point of departure from the mass of glass.



METHOD AND APPARATUS FOR DRAWING SHEET GLASS. U. S. 1,753,743. Apr. 8, 1930. John L. Drake, Toledo, O., assignor to Libbey-Owens Glass Company, Toledo, O. Filed 2/23/27. It has been found that better annealing can be achieved if the edge portions are trimmed from the main body of the sheet prior to or at the beginning of the annealing operation. This is an invention to provide in combination with sheet glass drawing apparatus rotatable means for automatically removing the edge portions from the sheet prior to the annealing thereof and while the same is still in a semi-plastic condition although substantially set in its final sheet form.

METHOD FOR MAKING LAMINATED GLASS. U. S. 1,751,052. March 18, 1930. William E. Nobbe, Toledo, O., assignor to Libbey-Owens Glass Company, Toledo, O. Filed 2/2/28.

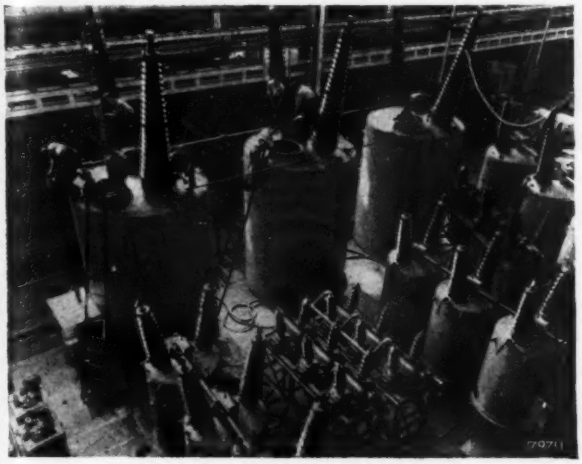
Pittsburgh Section—American Ceramic Society

The last meeting but one of the winter was held April 8 at the Mellon Institute, Perry D. Helser presiding.

Some considerable debate took place on the proposal of the Society to establish a Fellowship class, and opinion seemed somewhat evenly divided as to the merits of the scheme. The details of the proposal came in for more criticism than the basic idea. The section took no action beyond discussing the matter, and hoped to debate the subject further at the May meeting.

E. H. Fritz, of the Westinghouse High Voltage Insulator Company, was to have addressed the section, but was detained in Philadelphia. In his absence, Hobart M. Kraner, ceramic research engineer, Westinghouse Electric and Manufacturing Company, East Pittsburgh, gave a well-illustrated discourse on the development of high voltage ceramic ware.

The development of these high tension insulators has taken place almost entirely within the last fifteen years. The older in-



HIGH TENSION INSULATORS

sulators were first made by makers of dinner ware, and the ware was porous. The little insulation obtained was largely due to to the glaze. These were satisfactory for low voltages, but were quite unsuited for high tension lines. Just as refractories were the limiting factor in the development of metal and glass melting processes, so insulating materials were the limiting factor in the development of high tension transmission. They also limited the design of generating and transmission equipment, for if the conductors in a generator could be encased in a thoroughly sound, impermeable vitreous insulator, capable of standing the flexure to which it is necessarily submitted in assembly then generators could be made which would run at highest temperatures, and efficiencies—a matter that would assist design considerably. The present organic insulation will not stand high temperatures and will carbonize upon arcing over.

In the case of line insulators, development is limited mainly by the mechanical strength, which limits the weight of the cables that can be supported, and this in turn limits the current distributed. In very recent years, however, voltages have risen from 87,000 to 220,000, and the latter is now becoming fairly common.

High tension insulators of high mechanical strength are needed for bus-bars, for wall-bushings, for circuit breakers, lightning arresters, etc. They must be made of strictly non-porous, vitreous porcelain, steatite, or glass. The construction of typical circuit breakers and line insulators, both of the "pin" and the "suspension" types was explained with drawings and photographs. In the case of the circuit breaker for 220,000 volts, the outside column of porcelain was nine feet long, and the other end projected into the oil tank some five feet.

These large apparatus parts are made of slip-cast porcelain; the shells of line insulators are hot-pressed or jiggered.

The construction of lightning arresters was explained, and also the method of cementing together the parts of line insulators. From an engineering point of view, the suspension type is better and stronger than the pin type; also the latter is more prone to produce radio interference. The standard type of suspension insulator stands 16,000 to 18,000 lb. pull, and is loaded to half that in practice. It is possible to get such insulators that will stand 35,000 lb. Uniformity in strength is most important, as the whole line depends on its weakest unit.

The design of insulators is important down to the last detail, as the material is subject to such high stresses, and the necessity of keeping the overall length of a string of suspension insulators down to the minimum possible, results in severe taxing of the designer of the insulator.

Porcelain, like glass, is about twenty times as strong in compression, as ordinarily measured, as in tension; it has a modulus of elasticity of a very similar order, viz., 11,000,000 lb./sq. in. (Glass is commonly taken as from 9 to 10 million.) In most cases, glazing the porcelain increases its strength. Steatite is apparently somewhat stronger than either porcelain or glass, but it cannot be glazed satisfactorily, as the glaze combines with the body. Charts were given showing the resistance of various porcelains, sillimanites, steatites, and glass to bending, to thermal shock, etc.

An energetic discussion followed, in which a large part of the members joined. A great many points concerning the mechanical strength of porcelain and glass, the conductivity of testing oils, the suppression of arcing and corona tendencies in insulators, the texture of clays worked by different means, and so on, were brought up for debate.

Among those present at the meeting were:

Robert F. Ferguson	G. T. Stowe
Earl C. Petrie	F. L. Jones
Drury D. Turner	J. R. Crandall
C. E. Parmelee	George A. Wills
Jack H. Waggoner	George E. Crawford
F. W. Preston	W. Keith McAfee
L. R. Meyer	L. R. Kirk
P. D. Helser	O. M. Jenhansen
H. E. White	E. W. Scripture, Jr.
H. M. Kraner	Robert C. Boyd.
Fred Sauereisen	

The next meeting of the Section is scheduled for May 13.

Hobart N. Kraner

who prepared the paper here reviewed on high voltage insulators, was graduated in 1921 in ceramics from Ohio State University. He then took employment with the Bureau of Mines Ceramic Station, Columbus, Ohio, then joined the staff of the A. C. Spark Plug Company and later the Illinois Electric Porcelain Company. At present he is Ceramic Research Engineer in the Research Laboratories of the Westinghouse Electric and Manufacturing Company at East Pittsburgh, Pa.

Edward Miller on the Way to Europe

Edward Miller of the Miller Machine & Mold Works, manufacturers of glass house machinery, 705 Ann Street, Columbus, Ohio, left New York on April 26 for a tour of Italy, France, Belgium, Germany, Switzerland, Luxemburg, Holland and England. Mr. Miller will be accompanied by his wife.

Mr. Miller's first stop will be Rome, Italy, then to France, taking plane from Holland to England, then to Germany from where he will return home on the Bremen, July 9.

Mr. Miller is combining business and pleasure. His European address will be—British-Hartford-Fairmont Syndicate, 142 Audrey House, Ely Place, London, E. C. 1. Mr. Miller will visit a number of manufacturers throughout Europe.

Production Begins at New Henryetta Plant

The citizens of Henryetta, Oklahoma, enthusiastically celebrated April 25 to mark an event of importance in the town's development and progress, exemplified by the starting of manufacturing operations in the new two-million dollar window glass manufacturing plant just being completed by the Pittsburgh Plate Glass Company. Three hundred and ten days after ground was first broken for this factory, glass was being drawn.

The plant occupies a 40-acre site, all of which is enclosed in a modern wire mesh fence. There are 16 main buildings, in the construction of which more than 15,000 barrels of cement, 2,000 tons of steel, 1,500,000 brick and 49,000 square feet of window glass were consumed. During the construction period about 400 men have been employed regularly and under full operation the plant will provide employment for about 460 workmen. The annual payroll will amount to $800,000. The annual production capacity will be 950,000 boxes of single, double and triple strength. The new plant is designed to supply flat glass to the company's numerous warehouses in the territory between the Mississippi River and the Rocky Mountains. The main plant office has been placed in an attractive location and is surrounded with shrubs and evergreens. In this building are the offices of the superintendent, chief accountant, engineers, and clerks. Nearby is a time-clock building with a time recording system which is controlled by a master clock in the main office. The paymaster's office is in the rear of this building.

The clay building was the first part of the plant to be completed. It is 60 by 40 feet in size. The manufacture of clay shapes began September 9, 1929, in order to have the drawing blocks required in the company's modified Fourcault process properly aged and ready for use on the opening date. More than 8 carloads of clay have been manufactured into shapes. Most of the clay comes from Elwood, Indiana, but some of the raw product is imported from Germany. The clay building contains eight storage bins; two of thirty-carload capacity and six of forty-five carload capacity. Two bins are for silica sand which is shipped from Madill, Oklahoma, two for cullet which is made by the company itself and one bin for dolomitic lime which is obtained at Watts, Oklahoma. There is one bin for soda ash from Barberton, Ohio, one for salt cake which comes from Little Rock, Arkansas, and one for calcium limestone from Carthage, Missouri. All of these bins are of concrete construction and were built by the Rust Engineering Company of Pittsburgh. There are two elevators erected by the Stearns Construction Company to lift the raw materials from the cars to the tops of the storage bins. The mixing house adjoins the storage bin and contains a Rex mixer driven by a Fairbanks-Morse motor. There are eight Fairbanks open face spring scales of 2,000 pounds capacity for weighing the batch material as it comes from each of the storage bins.

The salt cake bin is equipped with an especially designed hopper and pulverizer. The materials are drawn from the mix house on an elevated track to elevator that hoists it to work floor of tank building. Another overhead track carries the material to where it is dropped into bins over especially designed automatic filling-machines. Each tank has a smokestack constructed of tile 130 feet high and eight feet in diameter on the inside at the base of the stack.

In the beginning two tanks will be operated. Each tank is equipped with the Company's specially designed sheet-drawing machines and with one No. 3 Clarage fan. There is one 15 foot Otis freight elevator in the No. 2 tank building.

Glass will be taken from the tank building to the four cutting rooms each 40 ft. x 360 ft. containing 25 stalls. Each cutting room has a fire wall.

The warehouse is immediately west of the cutting rooms and is the largest single building at the plant, being 200 ft. x 300 ft., with a fire wall extending through the center.

Water used by the plant in its manufacturing operations flows by gravity from a large lake into two plant reservoirs from which it is pumped into a tank ninety-three feet high, having a capacity of 60,000 gallons.

The maintenance building is one of the most important buildings of the plant, containing the power house, electrical repair shop, machine shop and carpenter shop. The power house equipment consists of two Westinghouse electric motor generator sets which rectify the AC current to DC current. There are two General Electric rotary converters which furnish current for electrical cutting-off devices in case of failure of AC current. One 248-volt battery equipment is on hand for emergency purposes. There is one transfer panel to direct current from Public Service Company to emergency batteries to supply current to DC sheet machine motors in case of failure of Public Service. There is one 240 h.p. six cylinder Buffalo gas engine directly connected to a 180 k.v.a. three phase sixty cycle 240 volts alternator, for standby electrical supply. There is one Fairbanks-Morse battery charger for charging emergency battery unit. The switchboard is of steel panel construction thirty-two feet long. The DC feeders are all of the open-air back-mounted Roller Smith circuit-breaker type. All outgoing circuits on AC power lines are of the Condit oil circuit breaker type. There are fourteen power feeders going out into the factory. All conduits are underground and encased in fiber duct and concrete. The transformer bank consists of three 150 k.v.a. transformers for power and two 75 k.v.a. transformers for lighting.

Adjoining the power house is the electrical repair shop equipped with one 12 in. Sidney lathe, one 12 in. Rockford drill press and one 8 in. United States grinder.

The machine shop is 60 ft. x 60 ft. containing the following equipment: one 20 in., 18 ft. bed American lathe; one 12 in., 6 ft. Sidney lathe, one 20 in. Rockford drill press; one 9 in. Peerless power saw; one 8 in. Oster pipe threading machine; one 4 in. Oster power buoy; one 3 ft. American radial drill; one 18 in. American shaper; one 12 in. United States grinder; one portable United States grinder; one 400 amp. Lincoln portable electric arc welder; three Oxweld welding outfits.

The carpenter shop equipment consists of the following: one J. A. Fay & Egan Company 30 in. band saw; one 12 in. Tannewitz wood worker; one 18 in. Porter crosscut saw; one J. A. Fay & Egan wood lathe.

Adjoining the machine shop is the blacksmith shop equipped with one Buffalo down draft large size forge and one Hossfield iron and pipe bender.

The roll room nearby is used for manufacturing asbestos rolls for the sheet glass drawing machines and has the following equipment: one 14 in. Rockford drill press; one 16 in., 16 ft. bed Sidney lathe; one especially designed pressing machine for assembling rolls. This room also includes two burning kilns one for drying asbestos discs and the other for storing the finished rolls.

The storeroom is immediately west of the maintenance building and contains all of the operating supplies and is open twenty-four hours daily. The first aid room is in this building and is completely equipped for any emergency.

The box shop is the latest building to be erected and contains the following equipment: four 26 in. nailing machines; one combined nailing machine and cleaving machine; one 36 in. nailing machine; one 40 in. nailing machine; one 52 in. nailing machine; four ripping saws; four crosscut saws. Thirty thousand feet of siding and 6,000 feet of heading are used in this building daily.

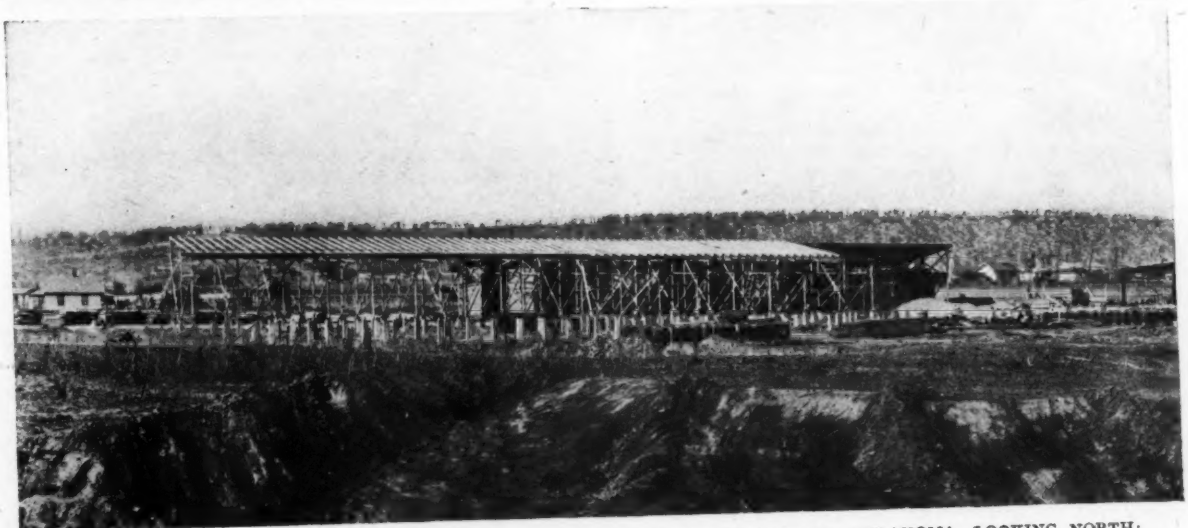
The hay house, 40 ft. x 60 ft., is the sixteenth building of the plant.

Sixteen lumber sheds are being built and have a capacity of 1,000,000 board feet.

Gas is furnished by the Central States Power & Light Corporation which has an almost unlimited supply of this fuel for industries. In addition to the gas supply, Henryetta is located in the center of one of Oklahoma's largest coal fields, thereby insuring an adequate fuel supply for all time.

Firms furnishing materials: Brick, Kusa Brick & Tile Company, Henryetta; firebrick and fire clay, Laclede-Christy Clay Products Company, St. Louis; silica brick and cement, Harbison-Walker Refractories Company, Pittsburgh; electrical supplies, General Electric Company, Schenectady, N. Y.; motors, Fairbanks-Morse & Company, Chicago; cast iron pipe for sanitary and storm sewer, Atlas Supply Company, Muskogee, Oklahoma; sand, gravel and cement, J. B. Croom Lumber Company, Henryetta, Okla.; steel, Muskogee Iron Works, Muskogee, and Carnegie Steel Company, Pittsburgh.

The Rust Engineering Company designed and constructed the eight concrete storage bins, the mix house, and two smokestacks. The W. S. Bellows Construction Company, of Oklahoma City, erected the remaining buildings. The Conard Nursery of Stigler, Oklahoma, did the landscape work. The site for the plant was given to the company by the Henryetta Chamber of Commerce.



NEW GLASS PLANT OF PITTSBURGH PLATE GLASS COMPANY AT HENRYETTA, OKLAHOMA, LOOKING NORTH:
Starting as shown in top view the buildings extend to the left one after another in a direct line from East to West, the layout being designed on the "straight line" production principle.

French Glass Manufacturers' Tour of Eastern and Central Plants

The two groups of sixteen representative glass and pottery manufacturers from France who had planned to visit some of the modern glass and ceramic factories in this country arrived at New York on April 9, behind their published schedule, due to the ungentlemanly behavior of the Atlantic Ocean which was so rough that a whole day was lost. In consequence the party spent only a few hours in New York and left early for Philadelphia.

Courtesy of *News-Bee*, Toledo, O.

LEFT TO RIGHT IN THE FRONT ROW ARE MAURICE THOUVENIN, PIERRE FAVRE, PIERRE MUNIER AND EUGENE LABECQUE. IN THE REAR ROW, LEFT TO RIGHT ARE, ANDRE GODFROY, GEORGES CLIGNET, JEAN MARQUOT, WILLIAM BABB AND JACQUES DURAND

The members of the French glass group were nine in number:

M. William Babb, Ingenieur aux verrerie a Vierzon, Godfroy Bouillion à Vierzon.
M. Georges Clignet, Ingenieur aux verreries Charbonneau à Reims.
M. Jacques Durand, Maitre verrier à Arques.
M. Pierre Andre Favre, Gerant de l'Union Verriere à Alfortville.
M. Victor Fournier, Directeur Technique de la verrerie de Vierzon.
M. Andre Godfroy, Maitre de verrerie à Vierzon, Godfroy Bouillion à Vierzon.
M. Jean Marquot, Verrerie Vve. G. Marquot & Fils, Bayel-Aube.
M. Maurice Thouvenin, Directeur de la verrerie de Vierzon.
M. Rene Vallot, Grossiste en ceramique et verrerie, 120 rue de Clignancourt, Paris.

Of these, M. Clignet is a bottle manufacturer, M. Favre a specialist in tube-drawing, and the others makers of stem ware, etc. There were no representatives of the flat glass industries.

The purpose of the present visit was to obtain a very general idea of American practice and customs. The visitors hope to return in 1931 for a more detailed and specialized inspection, and their friends here will look forward to seeing them again.

One woman, Mme. Edouard Fenal, whose husband is associated with the pottery group, accompanied that party on its special tour, differing in many respects from the route followed by the group of glassmen.

Arrangements for the tour were in the first instance placed in the hands of a travel bureau but the formalities of obtaining in advance the permission of glass plant owners to view their manufacturing operations had not been concluded. Consequently, and also on account of the delay in the arrival of the steamship *Paris* at New York, the suggested itinerary which had been prepared and published had to be considerably revised.

In and around Pittsburgh, a number of firms refused admittance on the ground that they were ahead of the times and wished to keep their advantage; others on the ground that they were behind the times and did not want others to know it; still others on the ground of complications introduced by patent litigation pending.

However, most of the difficulties were smoothed out and the visitors expressed themselves on several occasions during the trip as delighted with the numerous courtesies accorded them. Had the American Ceramic Society received earlier notice of the trip, Secretary Purdy, always anxious to assist visitors from other countries in every way possible, might have been able to overcome the objections of some of the factory executives to opening their plants for inspection.

From the Benjamin Franklin Hotel, Philadelphia, where the glass group had stayed over the night of April 9, the party was taken next morning by automobile to Bridgeton, N. J., where a special luncheon was prepared for them at the Cumberland Hotel. In the afternoon the plant of the Illinois-Pacific Glass Company at Bridgeton was visited and later a trip to the Tavern Rock Sand Company was made.

On Thursday evening a banquet was given to the visitors from abroad at the Cumberland Hotel. In addition to the foreign guests the following gentlemen were present:

Herrold D. Thropp, Eureka Flint & Spar Company; Peter Thropp, Eureka Flint & Spar Company; V. V. Kelsey, Consolidated Feldspar Corporation; W. A. Seger, Consolidated Feldspar Corporation; Thos. Graham, Tavern Rock Sand Company; Benjamin Hayes, Owens-Illinois Glass Company; Victor Durand, President, Vineland Flint Glass Works; Joseph Green, Kimble Glass Company; J. C. Reuss, Kimble Glass Company; Garrett Bechtel, American Oil & Supply Company; Chief of Police Walters, Trenton, N. J.

On Friday the party visited other New Jersey plants, the Vineland Flint Glass Works, Vineland; Kimble Glass Works, Vineland; Whitall-Tatum Company, Millville. Victor Durand, president of the Vineland Flint Glass Works gave a special luncheon for the guests. Friday evening the Frenchmen left for Baltimore and Washington and expressed themselves enthusiastically as having enjoyed their interesting and instructive trip through South Jersey.

At Pittsburgh

The party arrived at 8:05 a. m. Monday morning, April 14, in charge of T. A. Bean, of the Raymond & Whitcomb Company. They were met by Prof. A. Silverman of the University of Pittsburgh; R. C. Whitney of the H. L. Dixon Company, who acted as chief interpreter throughout the day; Ray D. Godard, also of the Dixon Company, who returned specially from Chicago to Pittsburgh to organize the local visits, and C. E. Frazier of the Simplex Engineering Company. After breakfast at the William Penn, Prof. Silverman had to leave, but the party was joined by A. W. Kimes of the *National Glass Budget*.

The original itinerary suggested for the Pittsburgh district as laid out in the last issue of THE GLASS INDUSTRY had to be scrapped in its entirety, and the party proceeded by automobile to the Glassmere plant of the Ford Motor Company. Here

the visitors were received by J. C. Ogle, superintendent, and Mr. McLaughlin, and conducted through the establishment in two sections. They were of the opinion that the plate glass manufacturing processes were similar, except in detail, to corresponding plants in France, but they would look forward to comparing it with the continuous process of the same company at Detroit.

The weather, which hitherto had been dull, now became definitely wet for some hours, and it being midday, the party sought refreshment at the Penn Lincoln Hotel at Wilkinsburg. Here M. Marquot distinguished himself by discovering French dishes which his compatriots overlooked. The meeting adjourned, and reassembled at the plant of the Wm. J. Miller glass machinery works, at Swissvale. Here Mr. Miller and V. J. Green had running a new example of the PCE milk bottle making machine, using wooden models to illustrate the action. In the absence of furnace heat, the mechanism could be observed with much more comfort and in much more detail than in a manufacturer's plant. There was also demonstrated the action of a feeder, and the machining operations on some of the intricate parts.

The visitors were now taken to Schenley, where they were escorted through the Mellon Institute. Very little of this had anything to do with glass, but the visitors expressed themselves as interested in such a venture in co-operative research, observing that while there were large private institutions, much larger than the Mellon Institute, in Europe, owned by the large companies, there was no provision for collaboration among smaller companies quite on the same lines.

By this time the weather had improved again, and the party enjoyed the trip to Washington, Pa. They commented on the excellence of the new concrete roads in this country, of which they reported that France had very few, and those mainly at the entrances to towns; on the Liberty tunnels, which they believed to be much longer than any in France; on the speed of travel, and on the backwardness of the Pennsylvanian spring.

Afterwards the whole party were the guests of Chauncey Frazier at a banquet in the George Washington Hotel. Here they were joined by F. C. Flint and A. Lyle of the Hazel-Atlas Glass Company, C. H. Modes of the Diamond Glass Company, Royersford, Pa.; Messrs. Teichmann and Campbell of the Simplex Engineering Company, E. W. Paxton of the Highland Glass Company, Mr. Wilson, Mr. Bean and Mr. Greer.

A program was mapped out for the next day, including visits to the Tygart Valley Glass Company, to Duncan & Miller Glass Company, and to the Findlay Clay Products Company.

A. W. Kimes of the *National Glass Budget*, who had joined the party at Pittsburgh, estimated that he had been asked a million questions by Mr. Durand during the day, and wished that his answers had been as intelligent as the questions. M. Favre considered that the distinguishing mark of a good American is to carry three cigars in the outside breast pocket, and he was practicing this in order to be able to pass as a native. Mr. Frazier distinguished himself by playing tiddleywinks with the tableware and somersaulting all the spoons at his end of the table into a Hazel-Atlas tumbler, which, he was careful to explain to his visitors, was one of Mr. Flint's products and was "junk." The last word puzzled the foreign guests, and had to be paraphrased somewhat elaborately into French by Mr. Whitney. A number of very excellent steel rules were distributed by the Simplex Engineering Company as mementoes, and as the Frenchmen explained that they had just passed two nights in the train, and were disposed to get an early start next day, to which they were looking forward with keen interest, the meeting adjourned at a comparatively virtuous hour.

From Washington, Pa., the party went on to Columbus, O., where they spent a day continuing their explorations into American glass factory methods, visiting among other places the headquarters of the American Ceramic Society where they were warmly welcomed by Secretary Ross C. Purdy. On Thursday morning April 17 they arrived in Toledo, and went to the Commodore Perry Hotel joining the group of pottery manufacturers who had sailed with them from France. Visits were made under the guidance of John Hova of the O'Neill Machine Company and W. L. Brownlee of the Buckeye Clay Pot Company. They inspected both of those plants, the Toledo Mould Company's works and the Toledo Porcelain Enameling Company's factory. They also visited the Libbey-Glass Manufacturing Company. Late that day they departed for Detroit, with the object of visiting the Ford Motor Company's glass works at Dearborn, Michigan.

The pottery and glass groups left Detroit by rail and arrived in Buffalo, Sunday morning, April 20. A motor trip to Niagara Falls was arranged for and on Monday the party was scheduled to arrive at Corning, New York, to visit the Steuben Division of the Corning Glass Works.

Soon after reaching New York, the visitors, expressing deep appreciation of the courtesies they received from the glass and ceramic industries throughout the manufacturing districts they visited, sailed for their home country on the DeGrasse of the French Line.

The Glass World and What It Is Doing

News of the Industry

Please Take Notice

The headquarters of THE GLASS INDUSTRY have been changed from 50 Church Street to the Scientific American Building, 24 West 40th Street, New York. The new telephone numbers are Chickering 2354 and 2355.

American Ceramic Exposition

A formal announcement concerning the American Ceramic Exposition which will be held in the public Auditorium in Cleveland during the week of February 22, 1931, was made on April 2 by Ross C. Purdy, secretary of the American Ceramic Society. The object of this exposition and congress is to make Americans conscious of the fact that in this country there are being produced ceramic wares that are inferior to none, and in many lines superior to those produced in other countries, and that for the several services for which the American ceramic wares of all sorts are designed, they are superior to the non-ceramic products. This it is hoped to do by meetings and exposition of wares, and by the several publicity means that are usually employed.

Anticipating the hearty cooperation of the entire industry Mr. Purdy suggests that members of the Society collaborate with the manager of the exposition, W. H. Eisenman, 7016 Euclid Avenue, Cleveland, O., in every possible way to make the enterprise a great success.

A New Trade Association

W. J. Parker, 7 East 44th Street, New York, who was instrumental in organizing the Feldspar Grinders' Institute, has announced the pending organization of a trade association by the clay mining companies, of which there are over one hundred in this country. There are over one hundred different types of clays produced and used in as many different products, including glass, glass melting pots, refractories, fire brick, tank blocks, floaters, drawing blocks and other glass factory necessities. The new organization will study the standardization of clays and carry on research work in an effort to improve the quality and find new markets for the clay, as well as for all products in which clay is or can be used. It is pointed out that freight rate problems, loading and shipping practices, and many other troublesome factors can be helped by cooperative study and effort. Full information concerning the new trade association may be obtained from Mr. Parker.

Libbey-Owens-Ford Merger Approved

The consolidation of the Edward Ford Plate Glass Company and the Libbey-Owens Glass Company, announced in the April issue, has been approved by the directors of the two companies, the new company to be known as the Libbey-Owens-Ford Glass Company. According to reliable reports, the accomplishment of the merger was due partly to the success which the Edward Ford Plate Glass Company has accomplished in developing the Bicheroux process, an intermittent method of manufacturing blanks for polished plate glass and thin sheets for laminated glass, first described in this country in THE GLASS INDUSTRY issue of September, 1927.

The Edward Ford Plate Glass Company is operating under a license obtained from the Bicheroux interests and the Libbey-Owens Company is interested in an organization formed in 1929, including the National Plate Glass Company of General Motors Corporation, and the Blue Ridge Glass Corporation, which, as announced some months ago, purchased and controls the United States rights to the process. The Blue Ridge Glass Company, controlled by the Corning Glass Works and the St. Gobain Company of France, thus becomes interested in the Libbey-Owens-Ford merger. It is estimated that the various plate glass manufacturing plants controlled by the Libbey-Owens-Ford Company will have an annual production of sheet and plate glass exceeding 55,000,000 square feet per year. The company also of course manufactures a tremendous quantity of sheet glass and is said to be the largest producer of laminated safety glass.

The merger is one of great importance to the plate and window glass industries. The Libbey-Owens Company, organized in 1916 by the late Edward D. Libbey and Michael J. Owens, and their associates, has been the outstanding leader of window glass manufacturers since its inception. Its securities sell on the New York Stock Exchange at a valuation of $50,000,000. In addition to its five plants in the United States it is affiliated with nine glass plants abroad.

The Edward Ford Plate Glass Company was organized in 1899 by the late Edward Ford, whose father, Captain John B. Ford, was the first successful manufacturer of plate glass in this country. The Ford Company at Rossford has been enlarged from time to time and has recently completed an extensive addition in which has been installed the Bicheroux process for plate glass blanks. It is also installing the improved Heuze method for grinding and polishing plate glass, another European development.

A recent addition to the company's laminated glass plant at East Toledo will more than double its original capacity.

Many outstanding financial and industrial interests are represented on the directorate of the new company. Among them are the Graham Brothers Corporation of New York, Lehman Brothers of New York, Potter Palmer of Chicago, Marshall Field of New York and Chicago, and Solvay of Belgium.

Officers of the Libbey-Owens Glass Company are: J. C. Blair, president; B. C. Root, vice-president and general manager; C. A. Schmettau, vice-president; H. E. Allen, vice-president; H. H. Baker, vice-president and secretary; R. H. Taylor, treasurer; C. O. Miniger, president of the Electric Autolite Company, is a member of the Board.

Officers of the Edward Ford Plate Glass Company are: George R. Ford, president; W. W. Knight, vice-president; D. H. Goodwillie, vice-president, in charge of manufacturing; C. E. Husted, vice-president and secretary, and G. P. MacNichol, Jr., treasurer.

Plan to Combine Glass Plants Is Dropped

The proposed deal between the Indestructo Glass Corporation, Farmingdale, Long Island, N. Y., and the American Plate Glass Corporation, Kane, Pa., looking to a combination of the two companies has been declared off, according to a reported statement by A. H. Gaffney, president of the latter company. Failure of the American Plate Glass Corporation's bondholders, to accept the offer made for an exchange of stock on a 60% cash value basis resulted in the withdrawing of the Indestructo Company's offer. The plant of the American Plate Glass Corporation at Kane, Pa., recently suspended operations.

Ralph Leavenworth with Austin Organization

In connection with the general expansion program of The Austin Company, international firm of designers and builders, George A. Bryant, Jr., executive vice-president and general sales manager, announced a short time ago the appointment of Ralph Leavenworth as assistant general sales manager. Leavenworth will have contact with sales activities at the headquarters office at Cleveland and the various branch offices throughout the country.

RALPH LEAVENWORTH
Assistant General Sales Manager
The Austin Company, Cleveland, O.

Prior to joining the Austin staff, Leavenworth was secretary and account executive of Paul Teas, Inc., advertising agency at Cleveland. He was account executive for The Austin Company.

Another phase of the expansion program of The Austin Company was seen in the recent announcement that it is inaugurating noiseless construction of industrial and commercial building with the electric welding of structural steel as a regular part of its service. The company will make welding or riveting optional with the owner. This is the first time in the history of the American building industry that electric welding has been offered as a practical proposition. Expansion of 50 per cent in the company's fabricating plant facilities is involved. It seems quite possible that welding, especially for city buildings, may completely supersede the noisy riveting method.

Projected Bottle Merger

Reports have been freely circulated during the past month to the effect that steps are being taken to accomplish a merger of the Thatcher Manufacturing Company and several other glass manufacturers. In the event of such a combination being formed the J. T. & A. Hamilton Company of Pittsburgh, who are said to be connected with the Thatcher Company through a bottle machine licensing agreement, is one of the concerns that no doubt would be taken over by the new organization. Details concerning the basis on which the proposed merger would be effected have not been made public.

Dr. Morey Lectures at Corning

Dr. G. W. Morey of the Geophysical Laboratory, Washington, gave a lecture to the Corning Science Club on April 1 on the potash-lime-silica glasses, with special reference to the crystalline phases formed in glasses of different compositions and at different temperatures. The work is an extension of that on the soda-lime-silica glasses, already published; the new work will be published shortly.

Merger of Glass Plants Rumored

Unconfirmed reports that negotiations for a merger of one of the largest glassware manufacturers with several smaller concerns are under way, were circulated throughout the Middle West during the past month, but no official news to that effect has been given out.

Prof. Turner Recovering from an Operation

Latest advices from England state that Professor W. E. S. Turner is in a nursing home whither he had gone for an operation. It is understood that he is progressing favorably and we with his many other friends in this country extend heartiest wishes for his speedy recovery.

Reduced Prices for Electric Apparatus

The General Electric Company has announced, effective immediately, price reductions of from 3% to 5% covering various standard lines of electric apparatus. These reductions are due to the recent recession in the price of copper.

Annual Meeting of Glass Container Association

As we go to press the annual meeting of the Glass Container Association is being held at the Hotel Traymore, Atlantic City, N. J., April 30 to May 2, 1930. Many subjects of interest to the trade were listed for discussion.

Trade Activities

F. C. Flint, chief chemist of Hazel-Atlas Glass Company, Washington, Pa., returned home about the middle of April from a trip to California. While there he flew from San Francisco to Los Angeles to visit his parents. Cloud banks forced the plane up to 15,000 feet, which is much higher than the usual level. Apparently Mr. Flint enjoyed it, for he says he will try to cover the whole distance to California by air next time. We hope however he will not go much higher, for no one wants him to go to heaven just yet.

W. B. Kochenderfer, formerly in charge of engineering and sales for The Lake Erie Engineering Corporation, Buffalo, N. Y., has recently been appointed chief engineer of the hydraulic machinery department of R. D. Wood & Co., Philadelphia, Pa., designers and builders of hydraulic presses for the manufacture of laminated safety glass, with works at Florence, N. J.

The American Crystal Company, Waterbury, Conn., manufacturers of sheet glass circles, etc., has been put into the hands of a temporary receiver, W. W. Gager, appointed by the Superior Court in that city.

W. C. Taylor, chief of the chemical division of the Corning Glass Works, is to make an extended tour of Europe this summer, visiting many of the principal glass plants there.

Frank E. Troutman, of Butler, Pa., was elected president of the Standard Plate Glass Company at a meeting of stockholders in Pittsburgh on April 16.

Recent Deaths

J. B. Krak

(*See page* 115)

Fred M. Locke

Fred M. Locke of the Research Laboratory, Victor, N. Y., who founded the Locke Insulator Manufacturing Company and was active in research work relating to glass, during the course of which he successfully developed a heat resisting glass and a formula for ultraviolet glass, died at his home in Victor, N. Y., on April 16. Grief over the recent death of his son and co-worker, Fred J. Locke, is believed to have shortened his life.

Frank Schilling

Frank Schilling, at one time active in the management of the former Charles Boldt Glass Company, Cincinnati, Ohio, died April 19, of heart disease.

Coming Meetings

The Illuminating Engineering Society will hold its 24th annual convention at the Hotel John Marshall in Richmond, Va., October 7-10, 1930. Sessions will be devoted to lighting practice, metal lighting, lighting service, ultraviolet radiation, lighting education, light in architecture and education.

American Refractories Institute will hold its annual meeting at White Sulphur Springs, W. Va., on May 19 and 20.

What The World Wants

China—44980. Containers, cigar, glass and other.
Brazil—44917. Novelty glassware.
Canada—44859. Glassware.
Argentina—45102. Glass—convexing, plate, machinery.
Japan—45092. Glass.
Mexico—45094. Glass—thin and medium thick, for mirrors and wooden mirror frames.

Inquiries Received

For further information address THE GLASS INDUSTRY

492. Would like to know where I can purchase literature on beveling, grinding, polishing and edging glass.

493. Please insert a notice in your magazine for the names of manufacturers of colored rod glass.

494. (From an Alsace-Lorraine glass factory.) We shall be greatly obliged if you will give us the addresses of all the American firms that make blowpipes either for removing the ends of blown goblets or for softening. As concerns the first type of blowpipes, we should especially like to know a firm making a blowpipe with a very fine flame having a circular arc 10 to 15 cm. in size or larger. We shall be greatly obliged if you will kindly give us also the addresses of American firms that make the most improved presses.

495. (From England.) We have seen advertised in your magazine a refractory tube recuperator for recuperative furnaces. Could you give us the names of United States manufacturers of such tubes?

496. Where can we obtain ground bottle stoppers?

497. We want to purchase laminated glass. Please give us the names of manufacturers in the vicinity of New York.

498. Where can we purchase glass safety jewels such as are used in bicycle lamps or signal devices?

Readers Wants and Offers

WANTED: An expert, familiar with the operation of glass tubing machines of the Danner type, is wanted for services abroad. Please apply Mr. I. P. Nikonoff, Amtorg Trading Corporation, 261 Fifth Ave., New York City.

The United States Tariff Commission desires to obtain copies of THE GLASS INDUSTRY issues of Vol. 8 (1927) May and July numbers. Will anyone in possession of these copies and willing to part with them kindly address THE GLASS INDUSTRY, 24 West 40th St., New York.

Also Wanted: All issues of Vol. 5 (1924).

Statement of the Ownership, Management, Circulation, etc., required by the Act of Congress of August 24, 1912, of THE GLASS INDUSTRY, published monthly, at New York, N. Y., for April 1, 1930, State of New York, County of New York—ss. Before me, a Notary Public, in and for the State and county aforesaid, personally appeared G. W. Cooper, who, having been duly sworn according to law, deposes and says that he is the managing editor of THE GLASS INDUSTRY, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, Glass Industry Publishing Co., Inc., 50 Church St., New York; editor, J. B. Krak, 50 Church St., New York; managing editor, G. W. Cooper, 50 Church St., New York; business manager, G. W. Cooper, 50 Church St., New York.

2. That the owners are (Give names and addresses of individual owners, or, if a corporation, give its name and the names and addresses of stockholders owning or holding 1 per cent or more of the total amount of stock): Glass Industry Publishing Co., Inc., 50 Church St., New York; G. W. Cooper, 50 Church Street, New York; J. B. Krak, 50 Church Street, New York; R. D. Proctor, 50 Church Street, New York.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are (If there are none, so state): None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements, embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him. G. W. COOPER, Editor. Sworn to and subscribed before me this 20th day of March, 1930. [Seal] ADA SHERNOCK, Notary Public. (My commission expires March 30, 1931.)

Current Prices of Glass-Making Materials

April 21, 1930

Quotations furnished by various producers, manufacturers and dealers.

Acid		Carlots	Less Carlots
Citric (dom.)	lb.	.46	.46
Hydrochloric (HCl) 20° tanks, per 100 lb		..	1.10
Hydrofluoric (HF) 60% (lead carboy)	lb.	..	.13½
52% and 48%	lb.	.10	.10-.11½
Nitric (HNO_3) 38° carboy ext. Per 100 lb.	lb.	5.50	..
Sulphuric (H_2SO_4) 66° tank cars	ton	15.50	..
Tartaric	lb.	..	.38
Alcohol, denatured	gal.	..	.52
Aluminum hydrate ($Al(OH)_3$)	lb.	.04½-.05	.05½-.06
Aluminum oxide (Al_2O_3)	lb	..	.07
Ammonium bifluoride (NH_4) FHF	lb.	..	.21-.22
Ammonia water (NH_4OH) 26° drums	lb.	.03	.03¼
Antimony, metallic (Sb)	lb.	..	.09⅝
Antimony oxide (Sb_2O_3)	lb.	..	.09⅝
Antimony sulphide (Sb_2S_3)	lb.	..	.14
Arsenic trioxide (As_2O_3) (dense white), 99%	lb.	.04	.04½
Barium carbonate ($BaCO_3$), Crude, (Witherite) 90%, 99% through 200 mesh	ton	47.00	..
90% through 100 mesh	ton	44.00	..
Barium hydrate ($Ba(OH)_2$)	lb.	..	.05-.05½
Barium mixture, glassmaker's, f.o.b. St. Louis	ton	25.00	..
Barium nitrate ($Ba(NO_3)_2$)	lb.	.08¼	.08
Barium selenite ($BaSeO_3$)	lb.	..	..
Barium sulphate, in bags	ton	..	..
Barium sulphate, glassmaker's, carlots, bulk, f.o.b. shipping point,	ton	15.00-16.00	18.00
Bone ash	carlots, lb.	.06	.06½
Borax ($Na_2B_4O_7 10H_2O$)	lb.	..	.0355-.0425
Crystal	lb.	.028-.033	..
Granulated	lb.	.025-.03	..
Powdered	lb.	.02875-.03375	..
Boric acid (H_3BO_3)	lb.	.0625-.07125	.06-.08125
Refined	lb	.0625-.07125	.07125-.08125
Cadmium sulphide (CdS)—			
Red	lb.	..	.90-1.00
Orange	lb.	..	.90-1.10
Yellow	lb.	..	1.20-1.25
Chromium oxide (Cr_2O_3)	lb.	.24	.25
Cobalt oxide (Co_2O_3)			
In bbls.	lb.	..	2.00-2.10
In 10 lb. tins	lb	..	2.15-2.25
Copper oxide			
Red (Cu_2O)	lb.	..	.30
Black (CuO)	lb.	..	.28-.30
Black prepared	lb	.	.30
Cryolite ($Na_3Al\ F_6$) Natural Greenland Kryolith)	lb.	.09	.10-.10½
Artificial or Chemical	lb.		.09½
Epsom salts ($MgSO_4$) (imported) Per 100 lb.		..	1.15-1.20
Feldspar—			
100 mesh	ton	12.50-20.00	13.50-22.00
80 mesh	ton	11.00-11.75	14.50
40 mesh	ton	11.00	13.50
Fluorspar (CaF_2) domestic, ground, 95-98% (max SiO_2, 2½%)			
Bulk, carloads, f.o.b. mines	ton	32.50	..
In bags or barrels	ton	36.50	41.50
Formaldehyde	lb.	..	.07½-.07¾
Graphite (C)	lb	..	.04-.07
Iron oxide—			
Red (Fe_2O_3)	lb	..	.0450
Black (FeO)	lb.	.04½	..
Kaolin (f.o.b. mine)	ton	9.00	..
English, lump, f o b. New York	ton	14.50-25.00	24.50-30.00

Kryolith (see Cryolite)			
Lead chromate ($PbCrO_4$)	lb	..	..
Lead oxide (Pb_3O_4) (red lead)	lb	.08	.09
Litharge (PbO)	lb.	.07	.08
Lime—			
Hydrated ($Ca(OH)_2$) (in paper sacks)	ton	10.50	..
Burnt (CaO) ground, in bulk	ton	7.00	..
Burnt, ground, in paper sacks	ton	9.00	..
Burnt, ground, in 280 lb. bbls.	Per bbl.	2.15-2.25	2.30-2.60
Limestone ($CaCO_3$)		2.00-2.50	..
Magnesia (MgO)—			
Calcined, heavy (in bbls.)	lb.	.06	.07
light (in bbls.)	lb.	..	.23
extra light (in bbls.)	lb.	..	.37
Magnesium carbonate ($MgCO_3$)	lb.	.06	.07-.10½
Manganese 85% (MnO_2)	lb.	.03	.03
Nickel oxide (Ni_2O_3), black— for nickel content	lb.	..	.35
Nickel monoxide (NiO), green— for nickel content	lb	..	.35
Plaster of Paris, bags	ton	21.00	23.00-29.00
Potassium bichromate ($K_2Cr_2O_7$)—			
Crystals	lb	.09	.09¼
Ground	lb	11	12
Potassium carbonate—94-96%	lb.	.0555	.0555
Calcined (K_2CO_3) 96-98%	lb.	.06½	.07¼
Hydrated 80-85%	lb.	.05¾	.06¼
Potassium chromate (K_2CrO_4)	lb.	..	.23-.32
Potassium hydrate (KOH) (caustic potash)	lb.	.07⅛	.08
Potassium nitrate (KNO_3) (gran.)	lb.	..	.05⅞-.06
Potassium permanganate ($KMnO_4$)	lb.	.16	.17
Powdered blue	lb.	..	24-.26
Rochelle salts, bbls.	lb.	..	.22
Rouge	lb.	..	..
Rutile (TiO_2) powdered, 95%	lb.	.15-.20	.20-.25
Salt cake, glassmakers (Na_2SO_4)	ton	22.00	..
Selenium (Se)	lb.	..	1.90
Silver nitrate ($AgNO_3$) (100 oz.)	per oz.	..	.30¾
Soda ash (Na_2CO_3) dense, 58%—			
Bulk, on contract	Flat per 100 lb.	1.22½	
In barrels	Per 100 lb.	1.55-1.57½	1.90-2.00
In bags	Per 100 lb.	1.37½-1.40	1.72½
Spot orders .025 per 100 lbs. higher			
Sodium bichromate ($Na_2Cr_2O_7$)	lb.	.07	.07½
Sodium hydrate (NaOH) (caustic soda) Solid	Per 100 lb.	2.95	..
Sodium nitrate ($NaNO_3$)—			
Refined (gran.) in bbls.	lb.	.03⅞	.04½
95 per cent	Per 100 lb.	2.16	2.30
Sodium selenite (Na_2SeO_3)	lb.	..	2.00
Sodium fluosilicate (Na_2SiF_6)	lb.	05	.05½
Sodium uranate (Na_2UO_4) Yellow or Orange	lb	..	1.50-1.55
Sulphur (S)—			
Flowers, in bbls.	Per 100 lb.	3.45	3.80-4.00
Flowers, in bags	Per 100 lb.	3.10	3.45-3.65
Flour, heavy in bbls.	Per 100 lb.	2.85	3.20-3.40
Tin chloride ($SnCl_2$) (crystals)	lb.	39	.37½
Tin oxide (SnO_2) in bbls.	lb	..	.40
Uranium oxide (UO_2) (black, 96% U_3O_8)			
100 lb. lots. Black	lb.	..	2.75
Yellow	lb.	..	1.50
Zinc oxide (ZnO)	lb.	.08½	.12
American process, Bags	lb.	.06½	.07
Zircon			
Granular (Milled .005-.02c higher)		.07	.07½-.08
Crude, Gran. (Milled .005-.02c higher)		.03½	.04-.05

Monthly Summary of United States Foreign Commerce in Glass

EXPORTS

Corrected to March 24, 1930

	February 1929 Quantity	February 1929 Value	February 1930 Quantity	February 1930 Value	Two Months Ending February 1929 Quantity	Two Months Ending February 1929 Value	Two Months Ending February 1930 Quantity	Two Months Ending February 1930 Value
Glass and glass products (Total)	.....	854,359	.....	701,994	.....	1,735,740	.....	1,491,346
Plate and window glass—								
Window glass, common, box 50 sq. ft.	1,840	10,211	618	2,738	2,875	16,379	3,494	18,518
Plate glass, unsilvered, sq. ft.	175,259	55,627	159,406	58,364	382,818	129,743	337,740	123,915
Other window and plate glass lbs.	249,748	30,180	532,377	47,298	574,059	67,330	904,881	75,351
Glass containers (bottles, vials and jars)	.....	255,750	.....	213,690	.....	534,590	.....	459,837
Table glassware, plain	.....	128,541	.....	89,782	.....	234,968	.....	210,103
Table and other glassware, cut or engraved	.....	6,650	.....	7,670	.....	14,570	.....	15,862
Lamp chimneys and lantern globes lbs.	142,489	29,836	99,957	20,770	279,641	59,025	183,486	37,230
Globes and shades for lighting fixtures lbs.	157,410	63,825	141,885	58,227	346,858	122,873	278,049	110,378
Chemical glassware lbs.	22,009	18,778	18,556	15,025	40,209	37,496	41,645	37,304
Electrical glassware, except for lighting lbs.	623,541	48,283	301,471	22,281	1,380,557	98,325	816,409	59,909
Other glassware	.....	206,678	.....	166,149	.....	420,441	.....	342,939

IMPORTS

Corrected to March 24, 1930

Glass and glass products	.....	1,155,464	.....	842,293	.....	2,277,945	.....	1,704,211
Cylinder, crown and sheet—								
Unpolished, not bent, obscured, beveled, etc.—								
Weighing less than 80 pounds per case dut. lb.	2,654,411	71,588	402,260	12,393	6,097,342	160,245	1,072,020	40,242
Weighing 80 pounds or over per case dut. lb.	2,214,736	85,736	1,725,793	65,843	5,456,302	206,279	3,986,172	152,463
Polished and bent, obscured, beveled, colored, etc., unpolished and polished, and all silvered dut.	.....	56,866	.....	31,817	.....	104,768	.....	75,764
Plate glass—								
Polished, unsilvered dut. sq. ft.	1,813,012	393,073	728,145	158,066	3,215,041	685,054	1,275,800	273,751
Other dut. sq. ft.	120,532	29,787	47,795	16,493	177,588	41,261	180,965	47,765
Bottles, vials, jars, demijohns and carboys, molded or pressed dut.	.....	24,388	.....	132,993	.....	53,739	.....	234,781
Table and kitchen utensils dut.	.....	19,262	.....	18,411	.....	36,117	.....	34,752
Glassware, cut or decorated dut.	.....	207,093	.....	133,644	.....	427,435	.....	300,789
Blown, glassware, n. e. s.—								
Bottles, ornaments, gauge glasses and other n. e. s. dut.	.....	33,955	.....	28,335	.....	100,877	.....	69,966
Bulbs for electric lamps dut. No. 1	1,886,049	14,101	1,247,384	10,612	4,032,633	31,597	2,952,185	25,650
Chimneys, globes, shades, prisms and other illuminating glassware dut.	.....	77,768	.....	104,999	.....	155,908	.....	162,239
Articles and utensils for chemical, scientific, and experimental purposes dut.	.....	36,180	.....	38,360	.....	77,154	.....	89,386
Other glassware dut.	.....	105,667	.....	90,327	.....	197,511	.....	196,663